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# BEEKEEPING IN CALIFORNIA

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An apiary in a sage location in Ventura County.

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# BEEKEEPING IN CALIFORNIA<sup>1</sup>

J. E. ECKERT<sup>2</sup>

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THERE IS NOTHING about the honeybee or its habits that the beginner cannot master if he studies the fundamentals before engaging actively in colony management. Too often, however, the beginner is unaware of the available information and acquires his experience painfully without the advice of others. This circular is intended to serve as a guide for those who contemplate acquiring bees for either pleasure or profit and to answer some of the questions received by the University of California College of Agriculture from these enthusiasts and from those who already own a few colonies but lack adequate knowledge of their care. The commercial beekeeper may also find some useful information in these pages. For more complete discussions of the subjects presented herein, the reader can consult the beekeeping literature listed at the close of this bulletin.

## THE BEEKEEPING INDUSTRY IN CALIFORNIA

According to all records now available, the honeybee is not native to California but was first imported in March, 1853. Of the 12 colonies originally landed at San Francisco only one survived and was moved to San Jose, where it cast three swarms the first season. Two of these swarms were sold at auction the same fall for \$105 and \$110, respectively. By importations and natural increases, the number of colonies in Santa Clara County alone reached about 1,000 by the beginning of 1860. John S. Harbison, a pioneer beekeeper of this state, was first to ship a carload of comb honey from California to Chicago in 1873, using the primitive type of equipment pictured in figure 1 to produce it.

From this modest beginning, bee culture here has grown into an important agricultural industry. At present there are estimated to be in California about 12,000 individuals who own approximately 360,000 colonies of bees, an investment of several million dollars. The annual production of honey in California varies greatly from season to season but ranges between 9 and 22 million pounds.

<sup>1</sup> This publication supersedes Agricultural Extension Circular 36, *Beekeeping for the Beginner in California*, by G. H. Vansell.

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The number of colonies per beekeeper varies from one colony to several thousand, although a majority of the beekeepers own a comparatively small percentage of the total number listed for the state. About 75 per cent of the California honey is produced by 5 per cent of the beekeepers. Approximately 50 per cent of all the colonies are located in the southern counties. In many sections the beekeeping ranges are overcrowded, especially in seasons unfavorable to nectar secretion.

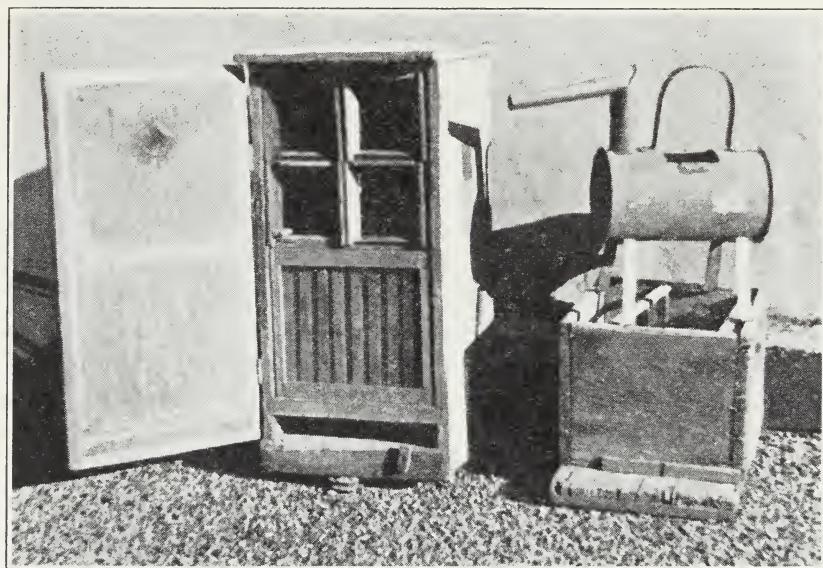


Fig. 1.—Two types of hives used when bees were first introduced into California together with an early type of bee smoker.

An important by-product is the beeswax secured from cappings and the melting of broken combs. The ratio between the amount of wax thus secured to a pound of honey varies with different methods of production but averages about 1 to 80, or 1 pound of beeswax for every 80 pounds of extracted honey. Where combs are entirely sealed before extraction, the ratio may be as high as 1 to 60. The amount of beeswax produced in California varies, therefore, with the production of honey and ranges between 112,500 and 250,000 pounds annually.

The third method by which beekeeping increases the wealth of the state is by the sale of bees and queens. California package-bee producers ship 30,000 to 35,000 packages of bees a year to the northwestern and Rocky Mountain states and Canada, and the demand is increasing. Each package contains 2 or 3 pounds of bees and one queen. As many or more queens are sold by breeders for the requeening of colonies. California

queens are shipped to practically every state in the Union and to the various provinces of Canada.

Although the production of honey and beeswax is often regarded as the bee's chief contribution, conservative estimates indicate that the increased value of the fruit and seed crops resulting from its activities as a pollinator is probably ten times greater than the value of the honey and beeswax. The honeybee is the only insect that can be increased and transported in sufficient numbers effectually to pollinate the vast acreages of fruit, vegetable, and seed crops grown. Without such services those crops requiring cross-pollination would be greatly reduced in quantity and quality and often would prove entirely unprofitable.

The honeybee is a conservationist—gathering, elaborating, and conserving a natural resource that would otherwise be lost. Nectar, unlike the naturally imperishable resources of the soil, such as coal, oil, and precious metals, must be gathered soon after it is produced. In collecting nectar and pollen, the bees do no damage to the plant, but increase the fertility and value of flowers by their activities in the dissemination of pollen. The orchardist and the seed grower, having long realized the value of the honeybee, are usually glad to furnish locations for apiaries in the vicinity of their fields. In many instances bees are sold or rented solely for pollination purposes during the fruit-blossoming period, and rentals of \$1.50 to \$3.00 per colony are not unusual. In regions where bees have been seriously injured by spray poisoning, such rentals are generally higher.

#### PRIMARY CONSIDERATIONS FOR THE BEGINNER

Certain considerations may aid the beginner in measuring his interest in beekeeping before making his initial investment in bees or equipment. These will be discussed briefly in the order of their importance.

*Physical Reactions to Stings.*—The sting of the honeybee generally hurts even the seasoned beekeeper, and in the beginner almost invariably causes a swelling that will last for a varying period of time—seldom more than two or three days. Unless a general systemic disturbance follows, the beginner need expect no serious consequences. It should be comforting to know that immunity to the poison can be acquired gradually until the effect is not noticeable after a few minutes. The pain of being stung is always felt for an instant, but one soon learns to wipe or scrape off the sting immediately and to proceed with the work at hand. With suitable clothing, properly adjusted, and with a knowledge of bee behavior, one can usually avoid being stung while working with pure-bred bees. The number of stings required to effect immunity will vary

with the individual. Some persons seem naturally immune, whereas others may require many stings over a long period.

The administration of adrenalin hypodermically by a physician gives almost immediate relief in cases of anaphylactic shock following the sting of a bee. This treatment should be given as soon as possible after a person exhibits any marked change in the pulse rate, or experiences difficulty in breathing within a few minutes after being stung.

*The Successful Beekeeper.*—Beekeeping can be undertaken by both men and women, young and old; it can be adapted to either small or large-scale production methods. Almost any normal person, with a liking for flowers and insects, who has the strength, patience, and willingness to work and the intelligence to learn the responses of the bee to its environmental conditions may attain success in this occupation. Beekeeping requires persistent effort and promptness in doing the right thing. It is not a business for the careless or lazy person. Honeybees are assailed by many enemies—*insects, spiders, birds, mammals, toads, bacteria, protozoans, and fungi*. They are dependent upon favorable floral and climatic conditions and upon the attention and care they receive at times critical for their very existence. The beginner, therefore, must be willing to study bee literature and to observe methods and bee behavior until he has acquired sufficient knowledge. As a rule, success follows in direct proportion to the beekeeper's experience, intelligence, power of observation, and business acumen.

*Returns to be Expected from Beekeeping.*—The amount of profit derived from bees depends to a large extent upon the availability and abundance of nectar and pollen-producing plants, upon favorable weather conditions while the flowers are in bloom, upon the strength of the colony, upon the skill used in the handling of bees and equipment, and upon marketing conditions. There are several sources of possible profit: the sale of honey and beeswax; the sale of increase, package bees, and queens; and the rentals received from orchardists and seed producers for the services of colonies in pollination. Of these three, the production of package bees and queens requires the most skill and the most exacting conditions in regard to location.

To secure an apiary site in territory where one or more major honey plants occur in abundance is very important. In California the blooming period of a nectar-producing plant is relatively short in comparison to the period when bees fly actively. For this reason beekeepers engaged in producing honey must, as a rule, move their colonies about in order to keep the bees in a honey flow. Commercial apiarists often occupy two to five different locations within a single year. This system

is called migratory beekeeping. Although the average permanent location may yield sufficient nectar for the colony and some surplus besides, this good fortune cannot always be expected in this state except in some irrigated regions where the nectar-secreting plants are not dependent on rainfall for moisture or where the location borders both a natural source of nectar and a cultivated area.

The average colony production in California varies from 30 to 50 pounds annually. Some colonies must be fed sugar sirup in order to remain alive during a dearth of nectar, while colonies in other locations may average 100 to 200 pounds or more of surplus under favorable conditions. Production and marketing costs and the market price then determine the amount of profit on the season's operations.

Besides the money return, the beekeeper generally takes into consideration the pleasure of working under healthful outdoor conditions. Many keep colonies simply because of an absorbing interest in the life history and habits of bees. Thus beekeeping becomes a diversion for the professional or office man.

Beekeeping as an avocation may fit in well with other occupations, such as fruit-growing and poultry-raising, especially in a location favorable to honey production. Or bees may be kept in out-apiaries some miles from the city and visited regularly in conjunction with a city occupation.

Again, many individuals prefer to market honey rather than produce it, and this field offers as good an opportunity as the field of production. Here also, the beginner should carefully survey the problems involved, study the marketing conditions, the sources of supply, the manner of processing honey for the retail market, and learn the chemical and physical properties of honey as well as many other factors before actively engaging in the business.

*Amount of Investment Necessary.*—The cost of getting started in beekeeping depends upon many factors; especially the number of colonies, the amount, kind, and condition of equipment, and the manner of securing the colonies. Where only a few colonies are to be kept, there will be less need for a honey-house or work shop, extracting equipment, tanks, stoves, trucks, and many other items needed by the commercial beekeeper. Equipment can be assembled and stored in some spare room of the beekeeper's home. A small trailer or the family car can serve for whatever hauling must be done.

The cost of established colonies varies in different localities and usually with the condition of the combs and equipment and the strength of the colony. A colony in a two-story hive may cost from \$5.00 to \$10.00. If new equipment must be purchased, consult a bee-supply catalog.

Based on the equipment required for one or five colonies, the following list will be representative, though prices vary from year to year:

	For Single Hives	For Lots of 5 Hives
One-story, 10-frame standard dovetailed hive, complete with		
Hoffman self-spacing frames, metal rabbets, and nails..	\$2.25	\$10.25
One hive body with frames.....	1.10	5.00
Two shallow extracting supers with frames.....	2.00	9.00
Medium brood foundation.....	1.35	7.22
Thin super foundation for shallow frames.....	0.55	2.50
Tinned wire.....	0.10	0.45
Root frame-wiring outfit.....	0.50	0.50
Spur wire-embedder.....	0.20	0.20
Queen excluder.....	0.65	3.00
Standard (tin) smoker.....	1.00	1.00
Folding wire bee veil.....	1.00	1.00
Hive tool .....	0.50	0.50
Paint.....	1.00	5.00
Three-pound package of bees and queens.....	3.40	17.00
	—	—
	\$15.60	\$62.62

The investment per colony will increase when the number is large enough to require the purchase of additional equipment required in the extraction, storage, and processing of honey and with increased transportation requirements. As the colonies are increased in number to where equipment can be purchased wholesale, the amount invested per colony will again be somewhat lower. According to recent surveys, the average investment for bees and equipment of commercial outfits ranges from \$7.32 to \$12.30 per colony. In Orange County, the average investment was \$6.40 per colony, estimated on the basis of 100 colonies.

*How to Get Started.*—Though many successful beekeepers have started on a small scale without experience, the majority have had previous knowledge of bee behavior and management. If the beginner does not have this information, he should strive to learn the fundamentals from books, bulletins, and journals before securing his first colony. He might also well acquire experience in the handling of bees by working with a successful beekeeper; most apiarists will help the beginner and will advise him on methods peculiar to his locality. Such practical experience will invariably indicate whether the enthusiast will wish to keep only a few colonies, to engage in the business on a larger scale, or to seek other fields of endeavor. For the novice to take over a large number of colonies brings almost certain discouragement, generally with the loss of most or all of the original investment. The next important step before actually securing the bees is to find a suitable location.

The beginner can purchase colonies already established in hives from beekeepers in the region where he intends to keep them or may buy package bees and install them in new equipment assembled in advance. In purchasing established colonies, the buyer should require an inspection certificate to insure freedom from disease. He should also examine the hives to determine the condition of the equipment, the amount of honey and pollen in the combs, and the strength of each colony. It is an advantage for the beginner to have colonies already established in hives. If package bees are secured, it is an advantage to start with new equipment and to watch the bees' progress in building new combs, starting their brood-nest, and pursuing the natural cycle of activities in a new hive. There is no danger of acquiring diseased colonies when package bees are installed on frames of foundation.

*The Best Season to Begin.*—The climate varies so markedly in various parts of California that it would be useless to discuss the best time of year for making a start. For the inexperienced, the best plan is to study beekeeping literature during the fall and winter and then to acquire the first colony in the spring when blossoms will supply the food requirements for brood rearing. The problems connected with spring management, swarm control, and supering for the honey flow are usually absorbing to the novice; but unless he has acquired some knowledge of bee behavior, as suggested, and has learned the possibilities of his location, the colony may attempt to solve its own problems by swarming. Of course, a start can be made at any season, provided the beginner learns the needs of the colony at that time and manages accordingly. General directions for managing colonies during the different seasons will be discussed later.

#### **LIFE HISTORY AND HABITS OF THE HONEYBEE**

The honeybee is a gregarious insect, able to survive only through the coöperative efforts of the three types of individuals in the colony: the queen, the workers, and the drones (fig. 2). Each caste has special duties, and the motivating impulse of the entire colony is apparently to insure the survival of the species rather than that of the individual. None of the three castes can live very long through individual effort. The instinctive reactions of the colony are exacting in that if an individual does not do the allotted work because of injury or old age, or if, as in the case of the drone, it is no longer needed, that individual leaves the hive, or is replaced by another, or is driven out to perish.

*The Queen.*—Under normal conditions, there is only one queen to a colony, and her sole duty is to lay eggs. Although she is the mother of

all the bees in her colony, she is lacking in mother-instinct; she apparently takes no interest in her eggs or in the resultant larvae. She is in no sense a ruler, but is purely an egg-laying machine. She is much longer than either the worker or the drone but resembles the worker except that her abdomen is greatly elongated during the brood-rearing period. Her wings appear shorter than the worker's because of the greater proportionate length of her abdomen; and her thorax is slightly larger than



Fig. 2.—Relative size of queen, worker, and drone honeybees. (From *Die Biene*.)

the worker's but smaller than the drone's. She has no pollen baskets nor wax glands. Her sting is longer than the worker's, has fewer and shorter barbs, and is curved.

The queen is fed almost entirely on a liquid food elaborated by the young worker known as a nurse bee. This food is presumed to resemble that fed to very young larvae. For this reason the number of eggs laid by a normal queen largely depends upon an equitable temperature in the hive and the amount of food she receives. This amount of food, in turn, depends mostly on the environmental conditions affecting the colony; so, although the queen can lay either worker or drone eggs "at will," she is governed for the most part by factors affecting the behavior of the colony as a whole.

During a dearth of nectar, brood-rearing is retarded or stops entirely. In most sections of California no brood will be found in normal colonies during certain periods of the fall and winter. Drone eggs are laid in drone cells sufficiently early in the spring to provide adult drones by the time the colony would normally swarm, whereas few if any drones are reared in the fall or during a nectar shortage.

The queen is reared in a special cell that usually hangs in a vertical position from the surface or lower portion of the comb. She develops from the same kind of egg as the worker; but the queen larva is fed on royal jelly, a much more nourishing food, and so emerges in a shorter time than either the worker or the drone. Within five to seven days after leaving the cell, the queen takes her mating flight and mates with a drone while in the air. The drone dies soon after the act of copulation, and the queen returns to her hive. She may mate with any drone flying at the time, a fact that makes controlled breeding difficult. The thousands of sperms received from the drone are stored within a special organ of the queen, called the spermatheca, from which they are released to fertilize worker eggs. As the queen ages, she gradually depletes her supply of spermatazoa and may lay an increasing number of drone eggs. If for any reason a queen fails to mate, all her progeny are drones.

When a queen shows any sign of failing, the worker bees usually prepare to produce another mother to supersede her and thus prolong the life of the colony.

Queens will live, as a rule, from one to three or more years, although most beekeepers find it profitable to change or introduce new queens every year or, at least, every other year. A queen's longevity depends upon the amount of work she does as well as upon her vitality and other inherited characteristics. She transmits to the colony every quality exhibited by the workers, thus controlling such important factors as temper, color, industry, character of comb building, and resistance to disease, so that it is important to keep only good queens of the best strains. A colony is, as a rule, no better than its queen.

The queen has a longer sting than the worker but rarely uses it except in combat or in killing other queens. Instances of a beekeeper's being stung by queens are extremely rare. The queen does not lose her sting in killing another queen.

*The Drone.*—The drone is a larger and heavier bee than the worker but not so long as the queen. Its large compound eyes come together at the top of the head while those of the queen and worker occur on the sides of the head. The drone is the only male bee in the colony; and its sole function in life, apparently, is to mate with the queen. The drone has no sting and lacks the many useful structures of the worker bee, such as pollen baskets and wax glands. As its tongue is short it depends, for the most part, on being fed by the workers.

Under natural conditions, where colonies live in trees, each colony contains many drones; but under domestic conditions, so many drones are not needed or desired, since many colonies are usually kept in one

place, or queens are reared and introduced under more controlled conditions. The number of drones in a hive is governed by the use of full sheets of foundation in every frame and by efficient wiring. Under such conditions, drone cells are to be found only in the lower corners of a frame and along the bottom bar. During the honey flow, the life of a drone is approximately 6 to 8 weeks.

*The Worker.*—The worker bees, although female, lack the fully developed reproductive organs of the queen. They are produced from fertilized eggs laid in worker cells. It takes longer to develop the worker and drone than the queen (table 1).

TABLE 1  
AVERAGE NUMBER OF DAYS IN THE DEVELOPMENTAL PERIODS  
OF THE HONEYBEE

	Egg	Larva	Pupa	Total days
Queen.....	3	5½	7½	16
Worker.....	3	6	12	21
Drone.....	3	6½	14½	24

The workers perform all the labor of the hive in a fairly definite routine. First, after emerging, they comb themselves, eat honey, and gain strength. Then they successively clean out the cells, nurse the older larvae, then the younger larvae, take orientation flights, clean the hive, evaporate nectar, build comb, act as sentinels and ventilators, and finally engage in the field duties of carrying water, pollen, nectar, and propolis. Their normal life period depends upon the amount of work they do, generally lasting for 6 to 8 weeks during the seasons of active flight. In winter, when they are less active, they may live for several months; and usually enough workers survive to carry on in the spring until others have been reared to take their places.

*Food Requirements.*—Honeybees secure their natural food materials from pollen and nectar. The pollen provides the bee with the protein that is absolutely essential to the growth of the larvae, whereas nectar provides the carbohydrates and the minerals. Worker bees can live on honey or on sirup made from beet or cane sugar and apparently require little, if any, pollen except to rear the brood. The nurse bees convert honey, pollen, and water into a very rich food known as royal jelly, which they feed to all larvae under three days of age and to queen larvae during their entire feeding period. After the third day, the worker and drone larvae receive coarser food consisting of honey and pollen mixed with the brood-food secreted by the food glands located in the head of the nurse bees.

The amount of food required by a colony during the year is difficult to determine; estimates of 170 to 300 pounds of honey per year have been made. It is generally agreed that a frame of honey and pollen is required for every frame of brood produced. The amount of pollen needed to rear an adult bee has been estimated at 0.1449 gram per bee (about 1½ times the weight of a young field bee); or 9.58 pounds of pollen per month per colony if a queen averages 1,000 eggs daily. For the best interests of the colony in California, a surplus of 20 to 30 pounds of honey and pollen should be present in the hive at all times.

*The Colony Nest and Its Arrangement.*—If, at the beginning of a honey flow, a 3-pound package of bees is properly installed in a single-story hive on frames of foundation and is examined after ten days or two weeks, it will be found under normal development that many of the frames have been filled with comb and that the combs thus drawn will contain brood, pollen, and honey. The brood will be in a compact arrangement in three or four frames with pollen in cells adjacent to the brood, while the honey will be stored above the pollen. As time goes on, all the foundation will be built into combs and the pollen will be concentrated, for the most part, in the frames located at either side of the brood chamber. Twenty-one days after the first eggs were laid, young worker bees will cut their way out of their cells, and the queen will deposit eggs in these same cells after they have been polished by the hive bees. In this way one may see in the same frame two or more cycles of brood, ranging from eggs to larvae and sealed brood.

A good queen will keep her brood in a compact arrangement and if given well-built combs will have very few empty cells among the brood. The eggs are attached by the queen to the bottom of each cell and extend upward. The resulting pearly white larvae remain coiled in the bottom of the cell until they have finished the feeding stage; thereafter they extend lengthwise of the cell, spin a silken cocoon, and are sealed in by the worker bees with a finely porous capping of wax.

The color of capped brood cells in a new comb is a light straw yellow, which, however, becomes darker as more generations are reared in the cells. The cappings of honey cells, normally white, may become travel-stained with propolis and pollen or may look "water-soaked" if the cappings touch the honey beneath. Pollen cells are usually only partially filled, hence are seldom sealed. Sometimes, however, cells containing pollen are filled with honey and then sealed so that externally they look like cells of honey.

When a colony is confined to a two-story hive without an excluder, the brood nest may extend into the second story and include brood in

ten or more frames. If the space for brood-rearing is limited to one or two stories, some frames may be entirely filled with brood, the honey and pollen being crowded to the outside frames. If the brood nest is confined to the second story only, as often happens in early spring in a colony wintered in two stories, much of the pollen will be stored in the lower hive body.

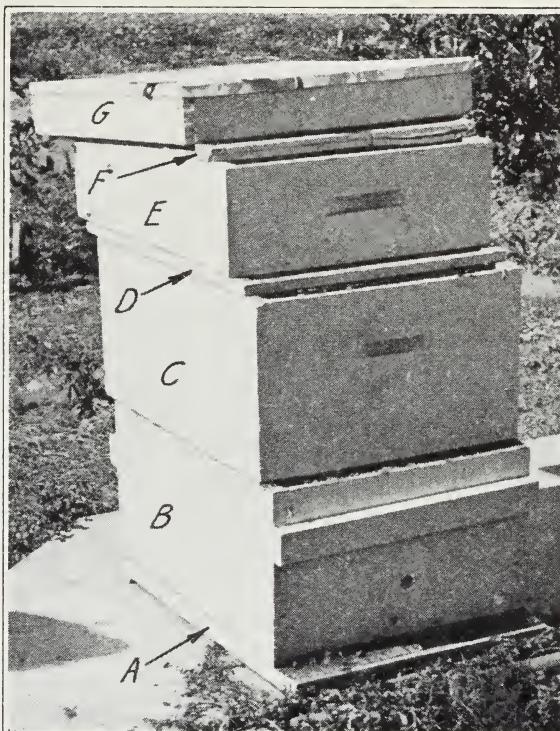


Fig. 3.—A 2½-story hive. *A*, Bottom-board; *B* and *C*, brood chambers; *D*, queen excluder; *E*, shallow extracting super; *F*, inner cover; *G*, outer cover.

The walls of the cells become somewhat thicker with age, but the silken cocoons are so thin and the cells are so thoroughly cleaned and polished each time after a bee emerges that the brood combs can be used for many years without any noticeable effect on the size of the bees produced in them. Old brood combs are very dark, almost black, and considerably heavier than newly built combs. Although darkened with use, they are clean and do not add color to any honey that might be stored in their cells.

The drone cells are confined, for the most part, to the lower corners of the frames if full sheets of foundation were used, or to portions of the combs that have been stretched or injured. Some beginners try to econo-

mize by using only half sheets of foundation; but this is false economy, since a large portion of the resulting combs will be composed of drone cells.

When queen excluders are used to confine the queen to the lower portion of the hive (fig. 3), very little pollen is carried above the excluder into the super combs unless frames of brood are transferred from the brood chamber into the super. Pollen in the supers is not objectionable unless comb honey is produced in sections or shallow frames. Normally, all surplus honey is stored above the brood.

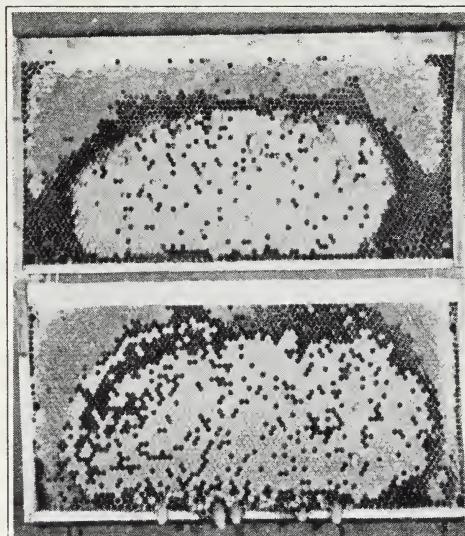


Fig. 4.—Brood combs with naturally built queen cells along the bottom bar and on the surface of the comb.

#### THE CYCLE OF THE YEAR

The various activities of a colony throughout the year are known as the cycle of the year. In describing the development of a colony or in observing the cycle, one may begin at any season. It is most interesting, however, to begin in the spring when activities are getting under way after the winter period.

If a colony has sufficient pollen and honey, brood-rearing may begin in the center of the cluster some weeks before the first spring flowers are in bloom. This constitutes a heavy drain on the pollen supply, and brood-rearing will be retarded later if the supply is not replenished from fresh sources. In some sections of California, particularly in parts of the southern counties, brood can be found in hives throughout the year.

With the opening of the first flowers the bees will eagerly seek what pollen and nectar they can find and will also carry water to mix with the honey in making the larval food. The first pollen and nectar of the year greatly stimulates brood-rearing. The young bees usually increase in number faster than the old bees die off, and the population of the colony gradually increases. If, as more nectar becomes available, the brood chamber becomes crowded, preparations will be made to divide

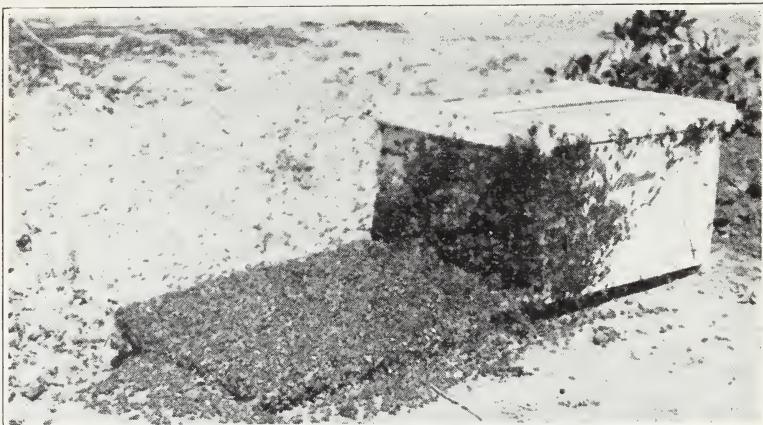


Fig. 5.—A swarm of bees running into a single-story hive.

the colony naturally by swarming. Queen cells will appear in numbers along the bottoms and sides of the brood combs (fig. 4), many more than are actually needed to assure the production of the queen that is destined to become the mother of the colony after the swarm and the old queen leave.

Some days before the swarm is to issue, interesting developments will take place other than the building of queen cells. The old queen gradually tapers off in the number of eggs she lays, thus reducing her weight for flying. Scout bees go out and actively seek a place in which the swarm can find a new home. More workers will remain in the hive, so that the colony begins to loaf; and many bees may cluster on the front of the hive. When the hive is on a stand above the ground, these clustering bees may form a "beard" below the entrance.

Then, at any time after the first queen cells are sealed, or even earlier, the majority of the field bees and many hive bees that are able to fly will sally forth with a great whirl and roar, and fill the air in the immediate vicinity of the hive with excited, swirling, happy bees, creating a high-pitched swarm tone that once heard is always remembered. After a few minutes of mad flying, small groups of bees will begin to cluster

here and there; but finally all will form a large cluster in one place. Swarming bees will cluster without any hammering on pots and pans and, apparently, are in no way affected by such mechanical din. After it has clustered the swarm can be hived as illustrated in figure 5. If the queen's wings have been clipped, she will be found on the ground before



Fig. 6.—A swarm of bees that built its combs in the open.

the hive; and after a few minutes of clustering, the swarm will return to its old home. If the queen is with the swarm, the cluster may hang for a few minutes to an hour or more before taking wing again and fly directly to its new home in one continuous flight. In rare instances swarms will build their combs in the open, as shown in figure 6.

Now let us consider that the swarm has gone and turn our attention to the hive whence it came. This hive will contain many frames of brood, a fair population of bees, and several queen cells in all stages of development. Some of the cells may be ripe, with the queens ready to emerge. The first queen to leave her cell often will go to the other queen cells, tear a little hole in the side of each, and sting the inmates. The worker

bees will then tear the cells down, drag forth the dead queens, and carry them from the hive. If a second swarm is to be cast, some of the queen cells will be protected from the wrath of the newly emerged queen, and a secondary swarm will follow the prime swarm within a few days. If the queen's wings have been clipped and the colony persists in swarming, the old queen will finally disappear and one or more young queens will emerge with the prime swarm. If no secondary swarm results, the population of the colony will soon be built up by the emerging brood, and work will continue as usual. As long as nectar is available, it will be gathered as surplus, if sufficient storage space is provided, to tide the colony over a period of dearth. This surplus is the beekeeper's remuneration for his labors in providing the necessary attention and equipment.

Toward the close of the nectar flow, the drones will be starved and driven out. This action of the colony is sure evidence of the termination of the nectar flow. The bees will also seek watering places in greater abundance, since they will no longer have the excess moisture from the evaporation of nectar for their needs in brood-rearing. More of the honey will be stored in the brood nest, and some already stored in the supers may be carried down and stored in the brood combs. This trait is particularly characteristic of the Caucasian bee.

Sometimes during the honey flow, instead of building swarm cells, the colony will build only one or two queen cells, and these will usually be found on the surface of the combs. In this event, the queen is failing, and the bees are starting to produce a "supersedure" queen to take her place. Under such conditions the young queen may emerge, mate, and start producing eggs while the old queen is still in the hive, and the old queen may continue to serve for many days. Sometimes two such queens are found in the hive in early spring.

With the approach of fall, brood-rearing is generally brought to a close, many old bees die, and the colony gradually dwindles from a great strength of 75,000 or more bees to about one-third that number. This reduction is gradual, extending over several weeks. The worker bees carry an increasing amount of propolis and make their hives tight for the adverse season that they evidently sense approaching.

As the days grow colder, the bees become less active; but instead of hibernating, as most insects do, they gather closely together to form a tight cluster whenever the temperature of the air surrounding them approaches 57° F. If the temperature of the air goes below this critical point, the clustering bees gather still more closely together, and through the insulating value of the cluster and the combs of wax and the activity of the bees, the temperature within the cluster gradually rises until at

no point is it below 57° F. The cluster is always formed on combs containing honey, and as the honey is used up the bees gradually move to other stores. In many places in California the bees are seldom confined to their hives for more than a few days during the winter; and for this reason, densely compacted clusters are formed only during the colder periods. Winter activity, however, may tend to shorten the lives of the workers, thus reducing the strength of the colony. This is especially true in regions where bees work on the eucalyptus bloom or other winter-blooming plants when the temperature of the air is below the critical point for the bee.

#### RACES OF BEES

All varieties of the honeybee in this country belong to a single species, *Apis mellifica* Linnaeus. As stated previously, all our hive bees have been imported from foreign countries, the first being the German black. This variety was followed by importations of others, commonly called races since they all interbreed. The German blacks were gradually replaced by the Italians, as they proved more desirable in many respects but primarily because of their resistance to European foulbrood, their bright color, and their quieter disposition. Of the many races tried, only three have met with lasting favor in the United States: the Italians, Caucasians, and Carniolans. All three of these are being produced in different sections of California. At present the Italians are the most popular, the Caucasians second, the Carniolans a weak third. Cyprians have also found favor with a few beekeepers; but they and their crosses are considered entirely too vicious by the majority who have tried them.

The *Italian race* of bees in this country is characterized by having three to five bands of yellow on the abdomen; the head, the thorax, and the remainder of the abdomen are black and covered with yellowish hairs. The darker strains of this race are commonly called leather-colored Italians, while the lighter-colored strains are known as five-banded, or goldens. All have been so interbred that distinctive strains are not easy to find. During recent years the trend in the selection of breeding queens has been to the production of the lighter-colored strain, although the leather-colored or three-banded bee is very popular. The Italian bees are prolific, winter well, are industrious, and are comparatively gentle when purebred; many strains are fairly resistant to European foulbrood. Italian queens are easier to find than those of the darker races. First crosses between the Italian and Caucasian or the Italian and Carniolan races, or the reciprocal crosses, are generally as desirable as the original strains; but second and third crosses are usually undesirable.

The *Caucasian race*, which originated in the Caucasus region of Europe, is distinguished by having two fairly distinct strains, one yellow, resembling the Italians somewhat in appearance, and one black with grayish pubescence. In California the gray Caucasians are far more popular than the yellow. Purebred Caucasians are gentle and very prolific, do not swarm excessively, and winter well. They have the longest tongues of any race of honeybee, and this characteristic may be of considerable value during seasons when, due to drought, nectar occurs in the lower portion of the corollas of flowers. They provision their brood nests well and regulate their brood-rearing activities to suit seasonal conditions better than most races. They are economical in using their stores during the winter. Purebred Caucasians and their crosses with Italians have been kept successfully in regions where European foul-brood is common; and other tests have shown that they are resistant to the disease, although possibly not to the same degree as the more resistant strains of Italians.

Caucasian bees will seldom bother the beekeeper by flying angrily in numbers about the bee veil—a very desirable characteristic. They will sting, however, when sufficiently provoked and, probably because of their longer legs, have more "leverage" and so are able to make more effective use of their defensive weapon.

Many Caucasian enthusiasts believe that this race will work at lower temperatures than Italians; but there is not sufficient evidence to warrant such a general statement. If this is true, the Caucasian bee would be useful in the citrus belt and for gathering nectar from the eucalyptus.

The greatest criticism against the Caucasians comes from their propensity to build burr and bridge combs that interfere with speed in handling combs. They also gather and use propolis more lavishly than any of the other races; but this is of less consequence than the fault just mentioned. Caucasians drift to other hives less than the Italians, a factor that might aid in reducing the spread of brood diseases. They are also said to rob less, but this fact has not been borne out by the writer's experience.

The *Carniolans* are found in Carinthia, Carniola, and Yugoslavia down to Dalmatia. They resemble to a certain extent the gray Caucasians. The segments of the abdomen are black, bounded by a grayish ring covered with a whitish pubescence. Carniolans are probably the gentlest of bees and are extremely prolific. Colony population increases rapidly in the spring, a fact that often leads to excessive swarming. This race undoubtedly builds more swarm cells than either the Italians or Caucasians.

The Carniolan-Italian cross results in a very prolific bee that winters well and has many desirable characteristics of both races. This cross appears somewhat more resistant to the decimating effects of buckeye poisoning than other strains. (See "Diseases of Bees.")

*The "Best" Race.*—Which is the best race of honeybee? This question is asked more frequently than any other in connection with the different races of bees. The German blacks or Holland bees, introduced into this country about 200 years before the Italians, are now difficult to find in any part of the United States. The Italians were popularized for 25 years or more before the Caucasians and met with great favor because of color and resistance to European foulbrood. The Caucasians and Carniolans have been handicapped, to a great extent, by their black color, which is still erroneously associated with a lack of resistance to European foulbrood.

The Carniolans cap honey cells whiter than either of the other two races but because of their propensity to swarm have met with less favor than either the Italians or Caucasians. Some enthusiasts claim that the Caucasians will store more honey than other races, but this has not been conclusively demonstrated for the different sections of California. Probably the answer to this question of "best" race is for a beekeeper to give each race a sufficient trial in order to become accustomed to its special characteristics and then to choose the most satisfactory. There is a distinct advantage in having only one race in any particular location, especially if the region is suitable for commercial queen rearing.

*Importation of Bees into the United States.*—In 1922 a federal law was passed prohibiting the importation of bees and queens into the United States except under the supervision of the United States Department of Agriculture, in Washington, D. C. This very wise provision was intended to forestall the introduction of certain bee diseases that have proved destructive in various foreign countries.

#### EQUIPMENT NEEDED

Before acquiring colonies, the beginner should decide what type of bee-keeping best suits his locality. Extracted honey or honey in shallow frames is undoubtedly the easiest kind of honey to produce. The 10-frame Langstroth hive is the best type to use, being standard among the great majority of beekeepers in California. Each hive should consist of a bottom-board, a brood chamber, at least two standard 10-frame hive bodies of the same dimensions as the brood chamber, an inner cover, and an outer cover (fig. 3). If the beginner expects to keep only five colonies or less, then each hive might well consist of two 10-frame hive bodies and

two to four shallow supers, together with tops and bottoms. Such equipment will permit the production of honey in shallow frames so that it can either be cut out of the frames in comb form or extracted. An extra bottom and top to take care of an increase of one swarm are also desirable.

*Queen excluders* are to be recommended in order that the queen and brood may be confined to the brood chambers. Queen excluders facilitate colony management in many ways and are essential where honey is produced in shallow frames.

*Hive covers* are of two principal classes: those that fit flat on the top of the hive and those that telescope a few inches down over its sides. When the former covers are used, no inner cover is needed; but with the telescope type, an inner cover of wood is almost essential, although some beekeepers cover the frames with burlap or canvas instead.

*The Smoker*.—The smoker, one of the most useful tools in the apiary, should be kept in good repair. The standard or jumbo type is recommended. Any smoker smaller than the standard is too small even for one colony. Copper lasts longer than tin if given proper care.

*The Hive Tool*.—The hive tool is used to pry the supers apart, to loosen frames, and to scrape burr combs and propolis from the frames and hive. Although various kinds are used, the 10-inch "Root" hive tool or one of similar pattern is most common. A serviceable hive tool can be made from spring steel with wooden handle. The scraping edge of the tool should be square and the corners rounded, not sharpened to a cutting point as is too frequently the case. Square edges and rounded corners will neither splinter the wood nor cut the operator.

*Bee Suits*.—The type of clothing worn in the apiary often influences the number of stings received. The veil, which should be the first consideration, should be of dark material, either wire or tulle, in order to afford the clearest vision. The folding wire veils sold by most manufacturers and supply houses are generally satisfactory. The cotton tulle veil with a silk tulle front gives especially clear vision. Whichever kind is used, the veil should be fastened down securely over the head and neck and entirely bee-tight even when the wearer is bending forward. Straw hats or hats covered with cotton cloth should be worn in the apiary instead of felt hats, as bees are prone to sting felt or flannel.

Light-colored clothing is preferable to dark, and cotton to wool or flannel. A zipper coverall that can be fastened at the wrists and ankles makes a very serviceable outfit. High-topped boots are generally worn, as a protection against stings, and sometimes bee gloves that come to the elbows. The experienced beekeeper, however, often works with sleeves rolled up and probably receives on the average no more stings than if

the sleeves were fastened at the wrist. Gloves are seldom used except when the bees are exceptionally cross.

*Comb Foundation*.—Comb foundation normally consists of sheets of pure beeswax embossed on both sides with cells of the size built by the bees. To secure combs of worker brood, the dimensions of the cells are made the same as those in which worker bees are reared. Straight combs of worker cells are essential to the proper management of bees, and

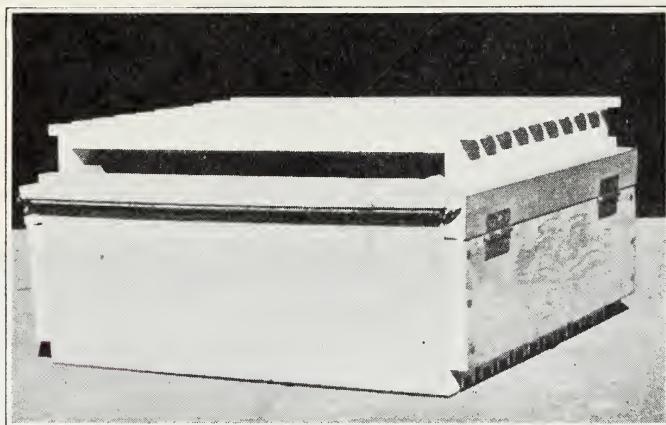


Fig. 7.—One type of frame-nailing device used in assembling frames.

these can be secured only where the frame is properly wired and full sheets of foundation are fastened in each frame. Although manufacturers also sell brood foundation with wires embedded vertically in each sheet of wax, most beekeepers use regular foundation and embed four horizontal wires.

*Miscellaneous Equipment*.—In assembling the equipment received "knocked down" (KD) from the factory, frame-nailing (fig. 7), wiring, and embedding devices will be needed. The beginner can purchase these or make them from the patterns of established beekeepers. He should not attempt to build his own hives or frames, for that method is usually more expensive, and accurate dimensions of frames and hive bodies are essential for ease of management.

Bee escapes, although helpful in removing surplus honey, are seldom used by the commercial beekeeper in California, who prefers to shake or brush the bees from combs or to drive them off by chemical means, as will be described later. Top and entrance screens for hives are recommended if colonies must be moved from one location to another with the greatest safety.

Extracting equipment consists of an extractor, an uncapping knife,

cappings box, strainer, and honey tanks. Extractors vary in size from 2 to 45-frame capacity. All but the 2 or 4-frame extractors are power-driven. The 2-frame extractor is very satisfactory for a small number of colonies. A solar wax extractor is a desirable piece of equipment even in a small apiary; it saves much wax that would otherwise be thrown away.

#### ASSEMBLING THE EQUIPMENT

*Nailing the Frames.*—The beginner should have little difficulty in assembling the hive bodies, tops, and bottoms but may be nonplussed sometimes when it comes to the frames. The frames should be nailed square with the aid of the frame-holder sold by bee-supply manufacturers or homemade for the purpose.

The end bars of Hoffman frames are pierced, with four holes in each for the wire that holds the foundation in place; and the wiring devices

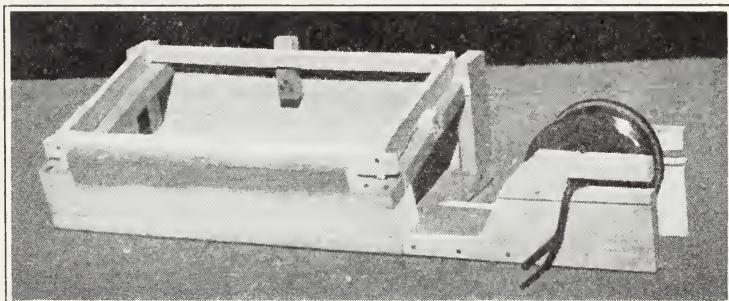


Fig. 8.—A device for wiring frames.

sold commercially are useful in placing the wire in the frames (fig. 8). Diagonal wires in horizontally wired frames add greater strength to the frame and aid in keeping the drawn comb from stretching near the top bar. The wires should be tight enough to "sing" when thumbed during stringing and yet not so tight as to cut into the end bars. Metal eyelets are sometimes placed in the holes to prevent wires from cutting into the wood. The frames should be placed in the frame-wiring device with the top bars next to the operator and with the cut-out portion of the top bar uppermost. The foundation can then be fastened into the frame by nailing down the strip in the top bar without shifting the frame after it is wired.

*Embedding the Wires.*—The most satisfactory way to embed wires in the foundation is to heat them sufficiently by electricity to sink them half-way through the sheets of wax. A simple wiring and embedding device, with transformer, is illustrated in figure 9 and needs no lengthy description. The transformer consists of a quart jar three-fourths filled

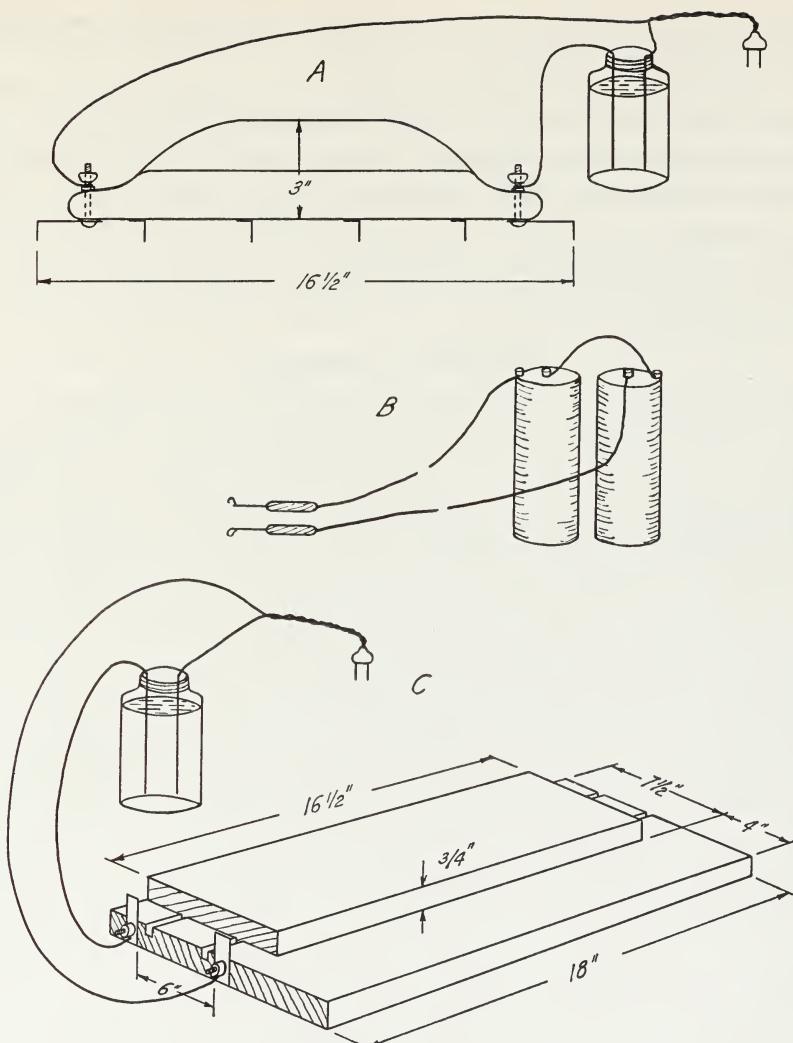


Fig. 9.—Devices for embedding wires in foundation: *A*, device for embedding single wires electrically, using a salt solution to reduce the strength of the current; *B*, dry-cell batteries for embedding; *C*, embedding board for embedding four wires at the same time.

with water in which about one-half teaspoonful of table salt has been dissolved. The amount of current coming through the transformer can be regulated by adding either salt or water, according to the strength of current desired.

The frame should be placed in the embedding device with the foundation beneath the wire. A slight pressure on the frame will cause the heated wires to sink in the foundation when the contact should be

broken. The wires should not be heated too long or they will buckle and burn through the foundation.

The spur-embedder or dry-cell battery unit are used to embed wires when electric current is not available. The spur-embedder is also a convenient tool when foundation is embedded electrically; with it one can fasten down portions of wire that are not properly embedded.

Foundation should not be embedded when cold; and frames of foundation should not be stored in cold rooms, since contraction of the wax caused by change in temperature will cause the foundation to pull loose from the wires.

#### SELECTING A LOCATION

Before investing in bees or beekeeping equipment, the prospective beekeeper should consider the matter of a suitable location. In placing an apiary he must know the nectar-producing plants and their blossoming dates. California is favored with nectar-producing flora of wide variety and seasonal distribution. From sea level to high in the mountains, nectar and pollen-bearing plants are to be found in varying abundance. The more important are listed in table 2. Each plant produces a nectar that is characteristic not only in the color but also in the flavor of the honey made therefrom. Fortunately or otherwise, the bees generally work on only one major honey plant during its blooming period, so that the beekeeper may, if he desires, keep separate the various honeys produced.

In an ideal apiary location there are sufficient flowers yielding pollen and nectar to permit the colonies to build up rapidly in the spring in time for a major nectar flow of long duration, followed by sufficient other plants to provide stores for the bees during the winter. The climate in most localities of California is such that brood-rearing extends over the greater part of the year; but the blossoming periods of the more important honey plants are usually short, seldom lasting for more than two months and often for not more than three weeks. Some of the plants produce a fine grade of table honey; others the stronger honeys used primarily in the bakery trade. At least half of the honey produced in California is gathered from wild flowers, and adequate rainfall, therefore, plays an important part in its production. Atmospheric and soil conditions likewise affect the quantity and quality of nectar produced by any particular plant. For this reason a plant that is a good honey producer in one locality may be worthless in another. A distance of only a few miles may make a marked difference in this regard. Many cultivated plants, such as citrus, alfalfa, and cotton are so sensitive to climatic conditions that their annual nectar production varies greatly. In the foothills surrounding the great valleys of California the California

buckeye (*Aesculus californicus*) whose nectar or pollen is poisonous to the honeybee, covers a wide range that would otherwise make excellent bee territory. Fortunately this plant does not extend into the more important sage and buckwheat locations of southern California. Many sections in the coast range would be favorable for honey production if fogs were not usually present during the blossoming periods of their more important honey plants.

As "ideal" all-year-round locations are evidently hard to find, many beekeepers have adopted a migratory system, moving their colonies from two to five times a year in order to keep their bees in a honey flow. Such a practice is expensive and calls for considerable equipment and labor. A location close enough for the bees to gather nectar from two or more major plants is very desirable and is probably as profitable over a period of years as the migratory system.

If bees are kept primarily for pollination purposes or as a hobby, so that surplus honey is of secondary importance, then almost any irrigated region and many mountain locations will provide adequate stores for them and some surplus for their keeper.

*Distance between Apiaries.*—Bees will fly an average distance of 1½ to 2 miles in quest of nectar and pollen, although they will fly much farther under certain conditions. It seldom pays, therefore, to locate apiaries closer than a mile apart unless the honey plants are especially abundant. The number of colonies in any particular region will also influence the number that should be kept in each apiary. From 50 to 100 colonies is the general rule, though some locations will support more. Beekeepers generally test each new location to determine the number of bees it will support and then regulate the number according to seasonal fluctuations.

Colonies are often kept in cities on the roofs of buildings, in the back yard, or on vacant lots. Whether in the city or in the country, the bee-keeper should not locate them where they will interfere with highway or pedestrian traffic or cause inconvenience around cattle-feeding lots, fruit-drying centers, garden pools, or to neighbors. If natural sources of water are not readily accessible, water should be provided near the bees. A little precaution may prevent discomfort or even accidents.

Natural windbreaks of brush or trees are advisable wherever the prevailing winds interfere with the flight of bees. In many portions of California partial shade is often essential during the summer months. This shade may be provided by boards laid on the tops of the hives, by arbors, or by shrubbery. During the winter, colonies generally fare better if their hives are not shaded.

*Arrangement of the Apiary.*—Concrete or stone foundations are advisable for permanent locations to prevent damage to the hives by dry rot and termites. Sometimes the hives in back-lot apiaries are placed on benches at a convenient working height. This is also desirable when toads, lizards, or skunks are abundant. Hives in out-apiaries are often placed directly on the ground in double rows, back to back, with sufficient space between each two such rows for a truck to pass through. Hives located in groups of twos or fours, in straight rows, make a better-looking apiary than hives scattered about; but often they cause the young bees or the returning field bees to drift with the wind into hives other than their own. As a rule, the entrance of hives should be faced away from the direction of the prevailing wind. This is not so necessary where windbreaks are provided. For obvious reasons, hives should not be located in an area infested with troublesome ants, near skunk dens, or near runways of bears.

#### NECTAR AND POLLEN PLANTS OF CALIFORNIA<sup>3</sup>

It is difficult to give an adequate description of the nectar and pollen plants for any locality in California because of the great diversity in climatic and soil conditions that obtain in various portions of the state. However, it can be said that of the 175 or more species of plants in California which supply the honeybee with valuable quantities of nectar and pollen, only a comparatively small number are of primary importance in the production of surplus honey in commercial quantities. These main sources are listed in table 2. Some of the honey and pollen plants of secondary importance, but which are valuable not only as sources for the stimulation of brood-rearing but also may produce, in favorable seasons, important quantities of pollen or surplus honey, are: button-willow (*Cephalanthus occidentalis*), California honey plant (*Scrophularia californica*), cantaloupe, carpet grass (*Lippia* spp.), cascara sagrada (*Rhamnus purshiana*), chia (*Salvia columbariae*), hollyberry (*Rhamnus crocea*), jackass clover (*Wislizenia refracta*), ladino clover (*Trifolium repens* var. *latum*), madrone (*Arbutus menziesii*), *Pentstemon* spp., *Phacelia* spp., poison oak (*Rhus diversiloba*), rabbit brush (*Chrysothamnus nauseosus*), snowberry (*Symporicarpos albus*), sumac (*Rhus laurina*), tamarisk (*Tamarix* spp.), wild lilac (*Ceanothus* spp.), and yerba santa (*Eriodictyon californicum*).

Although the California buckeye is listed among the major honey

<sup>3</sup> The data on distribution and value of honey and pollen plants were prepared with the assistance of Mr. George H. Vansell, whose bulletin *Nectar and Pollen Plants of California* appears among the recommended references listed at the back of this bulletin.

plants in table 2, it is a serious handicap in the foothills surrounding the great valley of California because of the deleterious effect of its nectar or pollen on bees. Its presence in these sections of the state often makes beekeeping unprofitable and many more locations would be available for the production of honey if this plant could be eradicated.

Certain plants, such as filaree, mustard, and chickweed, are so widespread throughout the state and are such valuable sources of pollen that they deserve special mention. Eucalyptus on the other hand, although it furnishes surplus nectar in some favored regions, may be considered to be undesirable in others because the blooming period comes at a time when many bees are lost by chilling while attempting to work its blossoms. This loss of bees is so great in many sections that colonies are greatly reduced in strength and thus weakened for more important nectar flows which follow.

Changing agricultural conditions bring about material changes in nectar and pollen-producing flora and beekeeping locations may vary accordingly. The accidental introduction of yellow star thistle, while proving detrimental as a weed, has greatly improved the value of beekeeping locations in sections of northern California. The use of mustard and sweet clover as covercrops for soil-building purposes has had the same effect in other sections. Intense cultivation, however, generally decreases the available nectar and pollen sources. For these reasons the University of California College of Agriculture will welcome any corrections that any beekeeper may have to offer in the information contained in table 2. In this table certain counties are not listed because of their small number of beekeepers. This condition may change in the future with sufficient improvement in the value of nectar-producing flora.

#### THE MANIPULATION OF THE HIVE

Handling bees is neither difficult nor dangerous if certain precautions are taken. First, the veil should be securely arranged to protect the head and neck; the bee suit or clothing to protect the ankles and body. Gloves are sometimes worn in the early stages of acquiring experience or if the bees are exceptionally cross; but they are soon discarded as too clumsy. The smoker should be well lighted and going properly. Although burlap sacking is probably the most common fuel, rotten wood, excelsior, or waste is serviceable.

Having all in readiness, approach a hive from the side, keeping out of the line of flight, and blow a puff or two of smoke into the entrance of the hive in order to disorganize the guards there. Then pry up the cover and, before removing it entirely, blow a little smoke across the frames.

TABLE 2

DISTRIBUTION OF COLONIES, PRODUCTION OF HONEY, AND THE IMPORTANT HONEY PLANTS OF CALIFORNIA\*  
(Major, M, and minor, m, honey plants)

County	Number of colonies	Averag <sup>e</sup> production per colony, pounds	Total crop, pounds	Averag <sup>e</sup> production per colony, pounds	
				Major	Minor
Alameda.....	2,700	75	202,500		
Amador.....	350	75	26,000		
Butte.....	7,000	80	560,000		
Calaveras.....	200	10	2,000		
Colusa.....	5,500	80	440,000		
Contra Costa.....	4,400	70	308,000		
El Dorado.....	900	60	54,000		
Fresno.....	13,000	100	1,300,000		
Glenn.....	6,000	70	420,000		
Imperial.....	14,000	50	720,000		
Inyo.....	3,500	55	202,500		
Kern.....	5,600	60	336,000		
Kings.....	4,300	90	387,000		
Lassen.....	2,000	50	100,000		
Los Angeles.....	36,800	80	2,944,000		
Madera.....	3,000	60	180,000		
Merced.....	3,500	65	227,000		
Modoc.....	900	90	81,000		
Monterey.....	3,000	35	105,000		
Napa.....	500	38	19,000		
Nevada.....	300	30	9,000		
Orange.....	9,100	85	773,500		
					Yellow star thistle
					Willow
					Asparagus
					Vegetables (carrot, turnip, etc.)
					Twisted
					Sweet clover
					Spikeweed spp.
					Sage (white)
					Sage (purple)
					Sage (creeping)
					Sage (black)
					Orange
					Mustard
					Moutain mahogany
					Mazatlanita
					Lima bean
					Honeydew (Inense cedar)
					Filagree
					Eucalyptus
					Deciduous fruits
					Cotton
					Coffee berry
					California buckeye
					Affalfa (wild)
					Blue cults
					Affalfa (cultivated)
					Total crop, pounds
					Averag <sup>e</sup> production per colony, pounds
					Number of colonies

TABLE 2—(Continued)

If the bees still have a tendency to fly out aggressively, puff some more smoke down between the frames, and replace the cover for a minute or two. Use no more smoke than is necessary to subdue the bees. The beginner often uses too much, sometimes disorganizing a colony so that for hours it will not resume its productive labors.

Since bees will stick the frames together at every point of contact, the hive tool must be inserted between the outside frame and the hive wall in order to pry the frame toward the center and then loosen it from the next frame by prying it back again before it can be removed. This frame should be set on end against the opposite side of the hive to facilitate the removal of the other frames. The frames should be held in a vertical manner when the comb is examined—preferably so that the sunshine will fall on the part being inspected. To examine the opposite side of the comb, lower one end and pivot the frame on the top bar, keeping the comb in a vertical position. In hot weather the comb becomes rather plastic and will either stretch or drop out of the frame unless this precaution is taken.

From time to time during the examination of a hive it may be necessary to puff a little smoke across the frames to keep the bees in a state of subjection. Avoid jerky or nervous movements, and do not jolt or jar the hive. Replace the frames in the same position in which they were found unless the condition of the colony can be improved by making a change. A frame should never be dropped into a hive but should be set in without a jar and without killing any bees. Injured bees emit poison, the odor of which often causes other bees to sting. The safety of the queen should always be kept in mind, for she is the most important bee in the hive. Careless handling of frames often results in injury to her. It is not good practice to set the frame containing the queen on the outside of the hive. If this is necessary, set out two frames with the queen on the inside surface of one of the combs.

Since the climate greatly influences the bees' temper, do not open the hive except under favorable conditions. Usually the warmer the day the less the bees' inclination to sting. A good nectar flow improves their temper and simplifies manipulation. It gives the field bees and the house-bees something to do; and busy bees are more contented than idle ones. A nectar flow also forestalls the danger of robbing. Avoid opening the hive when the weather is so cold as to chill brood or when the temperature is much higher than that of the normal brood nest (92°–98° F.). The experienced beekeeper can generally tell the condition of a colony by glancing at one or two combs or even by raising a super for a glance at the bottom bars and the top bars of the hive body beneath, a plan that greatly

reduces the time the hive is kept open. Although the novice should be encouraged to examine his colonies frequently in order to become acquainted with bee behavior, hives should not be opened except to provide sufficient room for brood-rearing or nectar storage or to improve the general welfare of the colony. Periodic inspections for disease should be made by every beekeeper, but these can be arranged in conjunction with other manipulative practices.

The results of each examination should be recorded either on the hive or in a notebook. Such information, properly dated, becomes invaluable in correcting errors and in outlining future work.

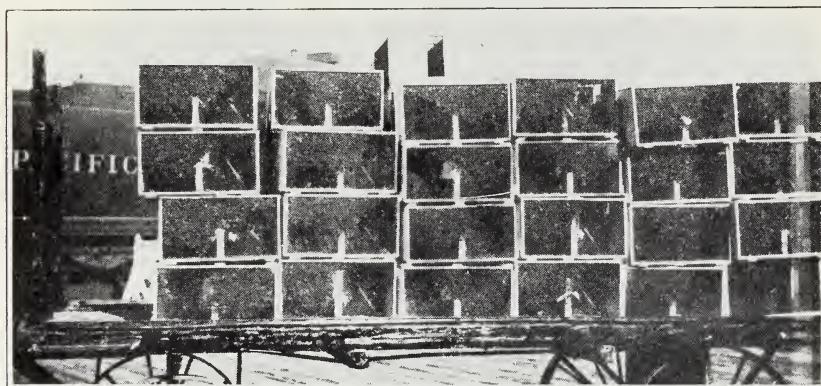


Fig. 10.—An express shipment of package bees after three days in transit. Note how the bees are clustering in the shipping cages.

#### INSTALLATION AND CARE OF PACKAGE BEES

Bees in combless packages are produced in quantity in California and shipped to the northwestern states and Canada (fig. 10). Some packages are also sold in California to increase the strength of colonies for the early honey flow in the southern counties or to start new colonies. To secure the greatest return from these bees, proper methods must be used in their installation and care. Each package contains 2 or 3 pounds of bees and one queen. The 3-pound package is the better size because the extra pound of bees enables the cluster to maintain a more uniform temperature during adverse weather conditions, thus increasing brood more rapidly.

*Best Time to Receive Package Bees.*—To strengthen colonies, the package bees can be added just before the honey flow, for nearly all the bees will become fielders within a few days. There is also considerable advantage in strengthening weak colonies 6 to 8 weeks before the start of a long honey flow in order to build up a desirable amount of brood to

maintain colony strength during that period. Where the packages must produce colonies for a honey flow, they should be received 8 to 10 weeks before the flow begins.

*Pollen Essential for Package Bees.*—Since bees cannot rear brood without abundant pollen, the newly established bees must be given combs containing pollen or must be able to secure pollen from flowers. If established on foundation, they should not be installed until weather and floral conditions are favorable for the gathering of pollen.



Fig. 11.—One method of installing package bees.

*Methods of Installation.*—Before the bees arrive, the hives should be made ready, and locations prepared. If suitable combs are available, each hive should contain at least two combs of pollen, even though some pollen is available in the field, and the equivalent of three full frames of honey.

Secure the packages from the express office as soon as possible after arrival and feed the bees as much sugar sirup as they will take when the sirup is painted on the screens of the cages in a warm room. Some bee-keepers spray the bees with sugar sirup or shake the sirup through the screen. Neither method is desirable, however, because some injury is done by wetting the bees with the sticky sirup. After feeding, the bees should be kept in a cool place until late afternoon. They will drift less if installed just before dark. If the day is cold and cloudy, however, they can be installed at any time with little or no drifting.

Method 1: Each hive should contain only five or six frames and should

have the entrance contracted to a 1-inch opening. An extra hive body, an inner cover or mat, and a 10-pound friction-top pail of sirup (warm sirup if the weather is cold) are also needed for each hive. Burlap sacking makes a good mat to cover the frames and keep in the warmth of the bees. Loosen the wire fastened to the queen cage, jounce the shipping cage on the ground, and remove the feeder-can with a twisting motion to avoid crushing the bees. Lay this feeder-can with adhering bees on top of the frames, and examine the queen cage to see that the queen

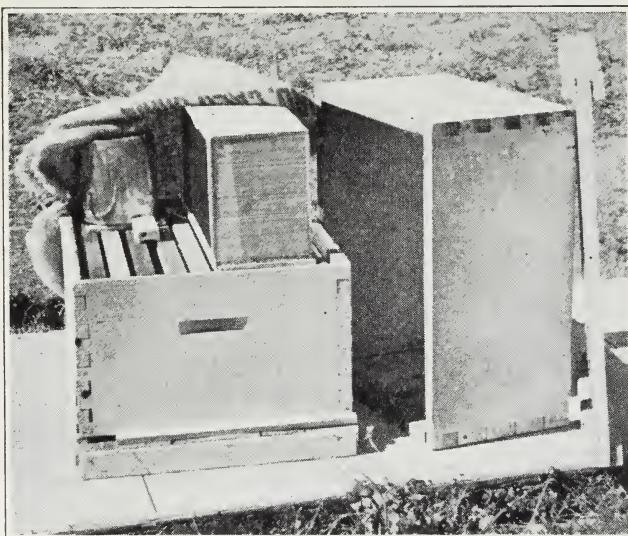


Fig. 12.—Another method of installing package bees in which the shipping cage is inverted over the frames inside of a hive body.

is uninjured. If she is in a three-hole provisioned cage, punch a hole through the candy opening of the cage with a match stem or a large nail, and hang the queen cage between two frames. The queen cage can be held in place between the frames by the pressure of the two frames or by the wire tied to the cage. Shake the bees that adhered to the feeder-can and also a good double handful of bees from the shipping cage on top of the frames over the queen cage. Place the shipping cage in the hive, top side up, in the space left by the missing frames; and lay a thin stick across the opening and the frames to provide bee space, if a mat is used. Invert the feeder-can in one corner of the hive on two small sticks, spilling some of the sirup over the frames while doing so. Put the extra hive body in place, cover the frames snugly with burlap and close the hive (fig. 11); or the frames may be left in place and the shipping cage inserted over the frames (fig. 12).

If queens are shipped in provisioned cages, push in the cork or metal piece, and plug the opening thus made with soft queen-cage candy or granulated honey. The queen cage should be laid wire side down over a space between two frames near the feeder-pail or inserted between two frames as described above, with the exit hole up. This can also be done with safety when the queens are shipped in provisioned cages. Having thus installed the bees and provided sufficient pollen, honey, and sirup,

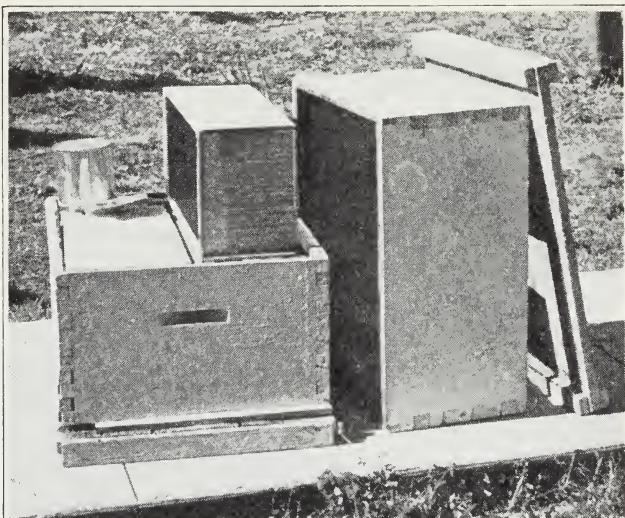


Fig. 13.—A safe method of adding package bees to a weak colony.

do not disturb them for at least 5 days. Some beekeepers remove the shipping cages and fill the hive with frames the day after installing the packages; but then there is always some danger of the bees' balling and injuring the queen because of the disturbance.

In a modification of this method used by W. A. Finlay, Provincial Apiarist of British Columbia, the empty hive body is placed on the bottom board to hold an open can of sirup (filled with straw to prevent bees from drowning) beside the shipping cage of bees. The full complement of combs can be given and the shipping cage removed later with less disturbance. The bees will take up the sirup within a day or two, but the feeder-can and cage need not be removed until it is safe to disturbed the hive for the purpose.

Method 2: This differs from method 1 only in that the bees are all shaken out of the shipping cage into the hive at the time of installation. The queen is handled according to the directions above; then four or five frames are removed from the hive to provide space in which to shake

all the bees from the shipping cage. The frames are then eased into position; the feeder-can and the mat are adjusted; and the hive is closed. This method works particularly well in cool weather when the bees are quiet in the packages; otherwise, greater drifting of bees will result than by the previous method.

*Adding Package Bees to Weak Colonies.*—When package bees are used to strengthen weak queen-right colonies, they can be ordered without queens if the queens in the colonies are satisfactory. If the colony is to be requeened, kill the queen a day before installing the package having a queen. One of the safest methods of introducing such bees to a colony is to remove all frames that the bees are not actually covering and fold one thickness of newspaper over the tops of the remaining frames and down over the exposed comb to the bottom-board (fig. 13). Punch a few small holes through the paper covering the side of the combs. After feeding the package bees all they will take, shake them into the side of the hive not occupied by the established colony, and then replace the other combs. When this method is used, the queen in the colony need not be caged. The bees will eat their way through the paper and join the cluster without fighting. A pail of sirup given at the time of introducing the package bees will increase the chances of a safe introduction. The bees should be installed in late afternoon.

#### SEASONAL MANIPULATIONS

*Condition of the Colony in the Fall.*—A colony in proper condition for wintering in the fall of the year will have a young queen, at least 7 pounds of bees of varying ages, and plenty of honey and pollen to supply all its needs until new food supplies are available. Each hive should be provided with a watertight cover and be protected from the prevailing winds of winter and spring. The entrance of each hive should be contracted to suit the strength of the colony in relation to climatic conditions and, if necessary, should be guarded against mice. Each hive will consist of one or two stories, two being generally preferred because the second story provides a food reservoir (often called a food chamber) against a failure of a honey flow in the spring. If climatic conditions warrant, each hive should be further protected from cold with insulating materials. Last, but most important, the beekeeper should know that each colony has a prolific queen and is free from disease.

Wintering colonies need little or no attention until they require additional room for brood-rearing or for honey storage in late spring. It is a good policy, however, to look at the hives occasionally during the winter season (without opening them or disturbing the bees) to see that

all is well. If for any reason a colony dies during this period, the hive should be taken into the work shop as soon as noted and not be left for the other bees to rob.

During the winter all beekeeping equipment, including spare combs, hive bodies, and extracting equipment, should be made ready for the spring and summer requirements. This includes repairs, nailing and wiring frames, and protection of spare combs from the wax moth.

*Spring Management.*—The first spring examination should be made on a warm day during the second or third cycle of brood, from 2 to 4 weeks after the first young bees have emerged from their cells; and the condition of the brood, amount of stores, and strength of colony noted. Do not look for the queen unless you want to clip her wings; and do not keep a hive open any longer than absolutely necessary. Any colony found infected with either European or American foulbrood at this time should be cared for immediately according to instructions given under the subject of brood diseases and their treatment. Supply any additional stores needed. Do not continue examining colonies at this time if the bees start robbing. With favorable weather conditions, brood-rearing will increase rapidly, and the colony will gain in strength soon after the first pollen and nectar are available. When the colony appears crowded in the brood chamber, additional room should be provided by adding a second or third story of empty combs. Frames of foundation should not be given unless the bees are gathering nectar.

*Swarm Prevention and Increase.*—Swarming, an inherited instinct of the honeybee, serves as a means of preserving and propagating the species. This instinct is stronger in some races, and even within certain strains of the same race, than in others. The tendency to swarm can be eliminated, therefore, to a certain extent by a careful selection of breeding queens. Chief among the many factors contributory to swarming are overcrowding in the brood nest, lack of storage space, old queens, lack of ventilation in the hive, and confinement to the hive by cold or rainy days during a honey flow. Swarming seems to be more persistent in some regions than in others, particularly so where there is a great variation between day and night temperatures.

Bees build numerous queen cells in preparation for swarming and often "hang out" on the front of the hive for some days. Such symptoms are advance notice that conditions in the hive must be made more favorable or a majority of the flying bees will leave for a new home previously located by "scout" bees. Some beekeepers depend upon cutting out all queen cells every 10 days to control swarming but this method is little used in commercial apiaries in California.

One method of swarm control that can be coupled with the making of increase is as follows: When a hive contains brood in both stories and will soon need additional comb space, lift the top story off, place a queen excluder on top of the brood chamber, put an extracting super in position, and place the former second brood chamber on top. Destroy any queen cells present. Nine or ten days later examine the hive again, and locate the queen. If she is in the top story, set this chamber aside on a new bottom-board, and supply a cover. If she is in the lower chamber, set this aside, and put the top story in its place. If the queen has laid in the super added ten days previously, add the combs containing eggs and larvae to the chamber set aside with the queen, exchanging frames of sealed brood for them if necessary. The two hive bodies on the original stand should contain mainly sealed brood, and all cells must be destroyed. If the queen is desirable, one of the queen cells can be left to requeen the colony; but it is best to introduce at this time a young laying queen, since the colony will then go ahead faster. This, as a rule, settles the swarming problem for the remainder of the season and provides one increase in the number of colonies. The two colonies can be united at the end of the season if the beekeeper desires.

A second method of making increase is to make one or two nuclei from each colony strong enough to occupy two brood chambers and having ten or more frames of brood. A nucleus is simply a small colony; its size is generally denoted by the number of frames of which it is composed. In making a three-frame nucleus, two frames with brood and one of honey, with adhering bees, are taken from a strong colony and placed in another hive; and one or two frames more of bees are shaken into the hive for good measure. The nucleus is then moved to another location in the apiary, and a queen introduced by means of the cage method. The entrance of the nucleus hive may well be contracted to 1 or 2 inches and closed loosely with green grass. Many of the field bees will return to the original stand; but enough young bees will remain to take care of the brood, the majority of which should be sealed. Such divisions should be made early in the season during a nectar flow to allow the nucleus time for reaching normal colony strength. If the season is sufficiently long, such nuclei may even become strong enough to store surplus later in the summer. Some experienced beekeepers use the nucleus method to rear their queens, introducing ripe queen cells instead of laying queens, and at the same time reduce the stimulus to swarm in the stronger colonies.

*Supering.*—Experienced beekeepers secure a maximum amount of honey by giving storage room so as to keep just ahead of the requirements of the colony. An examination of the combs is the best way to

determine when additional storage space is needed. This examination may include simply a glance at the top bars of the frames beneath the cover or at most the removal of one or two outside combs. If the combs are being whitened along the top bars by the addition of new wax, the comb-builders are lengthening the cells in which to store new honey, and more room will soon be needed.

Daily weight records of a scale colony often prove valuable in determining the periodic yields of the more important honey plants in any given area and indicate when supers may be required. Some experienced beekeepers make a practice of weighing a few hives in different parts of an apiary by lifting the back of each hive just off the ground by the hook of a spring scale before opening a hive. If the hives have not increased in weight since the last visit, the colonies in the apiary are not disturbed.

The amount of super room to give at any time depends upon the strength of the colony and upon the duration and intensity of the honey flow. Supers of foundation should not be given unless the colony is so crowded as to require more room for expansion, and then only if the nectar flow is intense enough and will last long enough to enable the bees to draw the foundation into comb. If the nights are cool, too much room in a hive is detrimental and may cause more bees to remain in the hive during the daytime to keep the hive warm. In supering a colony, it is generally good practice to place in the center of the super the two outside combs of the brood chamber, provided these do not contain brood, and to give two empty combs in their place. These combs, if filled with honey, will discourage the queen from coming up into the super in hives where no queen excluder is used. A second super, if needed later, can be placed beneath the first super after the bees have started to whiten the combs near the top bars of the first super. Supers added near the close of the honey flow should be placed on top.

Many beekeepers favor a shallow super because the amount of super space can be controlled better than where full-depth supers are used. Shallow supers may also be used as a chamber in which the bees can store a reserve supply of honey.

Some large-scale beekeepers in California use only two or three-story hives throughout the year and visit each colony often enough to remove the frames of surplus honey and add combs. It is good crop insurance, however, to have sufficient equipment to keep just a little storage space ahead of the bees at all times, especially in years of heavy nectar production.

The simplest method of producing extracted honey is to provide each colony with a two-story brood chamber, a queen excluder, and at least

two full-depth supers of nine combs. Bees will store as much honey in nine combs evenly separated as in ten placed closer together; and combs with cells extending beyond the wood of the frame are easier to uncaps. Colonies should be requeened annually with vigorous queens to reduce swarming and to insure strong colonies. Requeening may take place in the fall or after the first early honey flow in the spring. If colonies are wintered in one-story hives, the second brood chamber should be added when the bees cover eight or nine combs. When the combs of the second

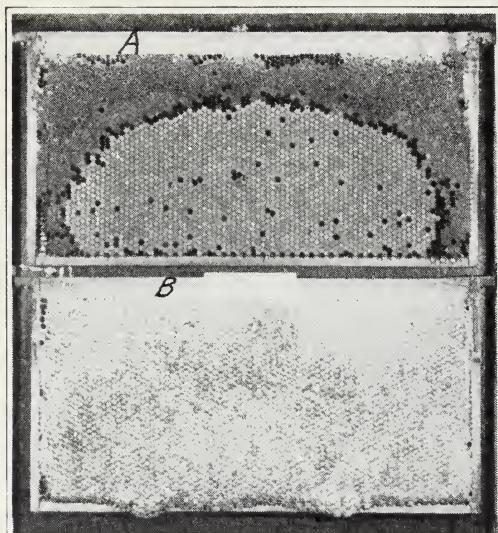


Fig. 14.—Frame *A* contains capped brood surrounded by sealed honey; frame *B* is a perfect comb of sealed honey.

brood chamber are being whitened around the top bars with new wax, the queen excluder should be put on, the queen confined in the lower brood chamber, and the first super added. Unless sufficient supers are available for the entire honey crop, each super can be extracted when the combs are one-half to three-fourths capped over, and the combs replaced for storing additional surplus. During early spring or late fall there is some danger of extracting unripened honey unless the major portion of the cells are sealed.

*The Removal of the Honey Crop.*—In the days of box hives and immovable combs, colonies were either "driven" or killed with fumes of burning sulfur before the honey was removed; but with the movable frame hive, these practices are no longer necessary. The bees may be freed from the combs of honey by shaking and brushing, by the use of the bee escape, or by carbolized cloths. Most commercial beekeepers use

the first or last methods, for, unfortunately, the bee-escape board is not feasible in most out-apiaries because of the theft of honey.

The majority of bees on a comb can be shaken off with a quick downward and upward movement, and the remainder brushed off with the bee brush. This method is most adaptable when bees are not robbing. Honey should not be taken off by this, or any other method, when it is so thin as to be shaken readily from the combs, but should be left to ripen. Sealed honey (fig. 14) is well ripened and ready to be extracted. An empty hive body should be provided at the start to hold the combs of honey as fast as they are freed of bees.

The *bee escape* is a device so constructed that bees may go through it one way only and cannot return because of one or two sets of springs. When this device is placed in the center of an inner cover or ventilated bee-escape board, with the entrance up under a super of honey, the super will generally be free of bees by the following morning. Bee-escape boards are much used in removing comb or shallow-frame honey and cause little disturbance to a colony. Unless the super above the bee-escape board is bee-tight, the combs are liable to be robbed by other bees. The bee-escape board should not be left on during hot weather, for combs may melt down.

*Carbolized cloths* have become fairly popular during the last few years and if properly constructed and used enable one beekeeper to take off honey faster than two can by the shaking and brushing method. Since carbolic acid burns the skin severely, the cloths to be carbolized should be nailed to a rim of wood large enough to slip easily down over the top of a hive body. The sides of the rim need not be more than 2 or 3 inches wide. A durable cloth of fine mesh is desirable. This should be tacked on to the rim and then covered with a thickness of tar paper or with tin painted black. If tar paper is used, screen wire should be tacked over the paper to keep it from being torn. The tar paper serves not only to make the hive airtight above but also to absorb the heat of the sun, thus making the cloths more effective.

The cloths need be sprinkled only once a day with a 25 per cent solution of carbolic acid. A stock solution of the acid is made by liquefying carbolic acid crystals (C.P.) in a container surrounded by hot water and adding an equal volume of water. This is assumed to be a 50 per cent solution. The cloths should remain in place only long enough to drive the bees from the super to be removed. If left on too long, the fumes may drive a majority of the bees out of the hive. To speed the operations, the commercial beekeeper generally uses eight such screens for each crew of two men removing supers from the hives and loading on a truck.

*The Process of Extracting.*—The honey extractor is a machine that removes honey from the comb by centrifugal force. Extractors are manufactured with a capacity of two to forty-five frames. A 2-frame extractor with baskets that can be reversed without removing the combs is large enough to take care of at least 20 colonies. The combs are first uncapped on both sides with a hot knife (a steam-heated uncapping knife is best) and then placed in the baskets of the extractor. The baskets are turned slowly at first until part of the honey is removed on one side; then they

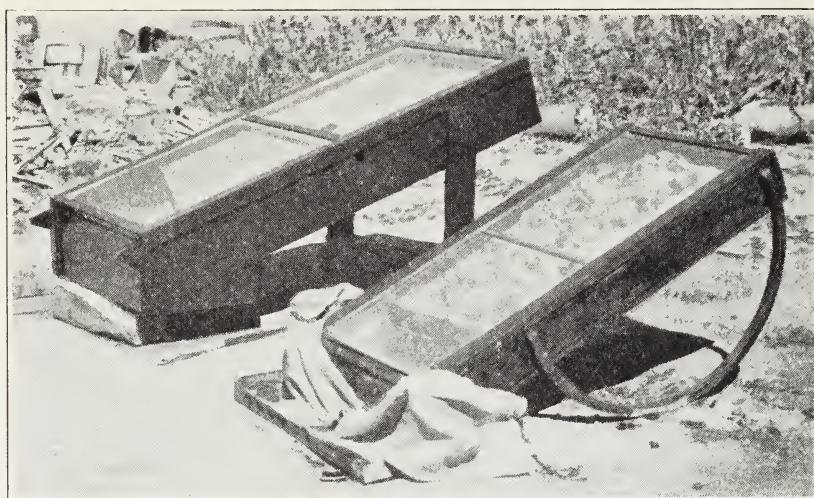


Fig. 15.—Two solar wax extractors loaded with cappings. The receptacle at the bottom end of each catches the melted beeswax.

are reversed, and the process is repeated. To get all the honey out, the speed must be increased, but not sufficiently to break the combs. New combs especially are easily broken. The honey drained from the extractor is strained through a wire screen and fine cloth to remove all particles of wax. Honey is easiest to extract before it loses the warmth of the hive. In cool weather or with heavy honey one must heat the honey in a water-jacketed tank to facilitate straining. The most suitable cloth for this purpose is 86-mesh bolting cloth. Double thickness of cheese cloth will remove most but not all of the foreign particles. If heated to 145° F., the honey will strain readily. Most of the bubbles incorporated in it during extracting and straining will rise to the top if the warm honey is allowed to stand in a tank overnight; then it should be put in suitable containers. If honey is canned or bottled immediately after being strained, the small bubbles will form a white, unsightly scum on the surface. Honey will discolor if kept hot for too long a period.

*Cleaning the Combs.*—If the honey flow is still in progress, the frames can be placed back in the hives to be refilled; but if it is at an end, the combs can either be stored as they are removed from the extractor or given to the colonies to be cleaned. If there is danger of robbing, the "wet" combs should be put on the hives in late afternoon, left for a few days, and then removed with bee-escape boards. Three or four supers can be stacked on each hive.

*Caring for the Cappings.*—The cappings cut from the combs should be permitted to drain overnight and then melted in a solar wax extractor (fig. 15) or in water. Clear beeswax has a ready sale at all bee-supply houses. Wax that is boiled or rendered in iron or galvanized iron vessels is darker than if aluminum vessels are used. To prevent the cake from cracking, the melted wax should be poured into the molds at a low temperature and kept covered to cool slowly. The sediment on the bottom of the cake should be scraped off. Wax presses are not necessary unless many old combs are to be rendered.

#### THE HONEY HOUSE

Honey, being a food product, should be produced and extracted in a sanitary manner. The honey house should be well screened against bees, and honey tanks and containers well covered to exclude dust. A concrete floor in the extracting room can be kept cleaner than a floor of wood. To prevent bees from being carried into the extracting room with the supers of honey, unload the supers in another room, and permit all bees to escape there. Arrangements can be made to keep this room warm in order to facilitate the extraction.

Many migratory beekeepers have portable equipment for extracting in or near their different apiaries. These outfits likewise should be well screened, and the honey pumped from the extractor into closed tanks. Floors of wood or canvas should be used in such extracting rooms and cleaned after each day's operation.

A suitable warehouse truck in the honey house saves much heavy lifting of supers and honey cans. It also speeds up operation, in that hive bodies can be handled in stacks rather than individually.

#### WORK IN THE FALL AND WINTER

Each colony should have sufficient honey and pollen in the fall to last until the spring supply is available. With an early dependable spring honey flow, 30 pounds of stores will be sufficient in most parts of California. Otherwise, it will be good crop insurance either to leave more in the hive or to store combs of honey to give to the colonies in the spring.

This practice is generally followed in the case of out-yards that are subject to molestation during the winter period.

In some sections of the state where fall and spring flowers are scarce, the beekeeper should see that each colony has sufficient pollen for early spring brood-rearing. As some hives may have more than they need, any surplus can be distributed among the needy colonies. Colonies worked in

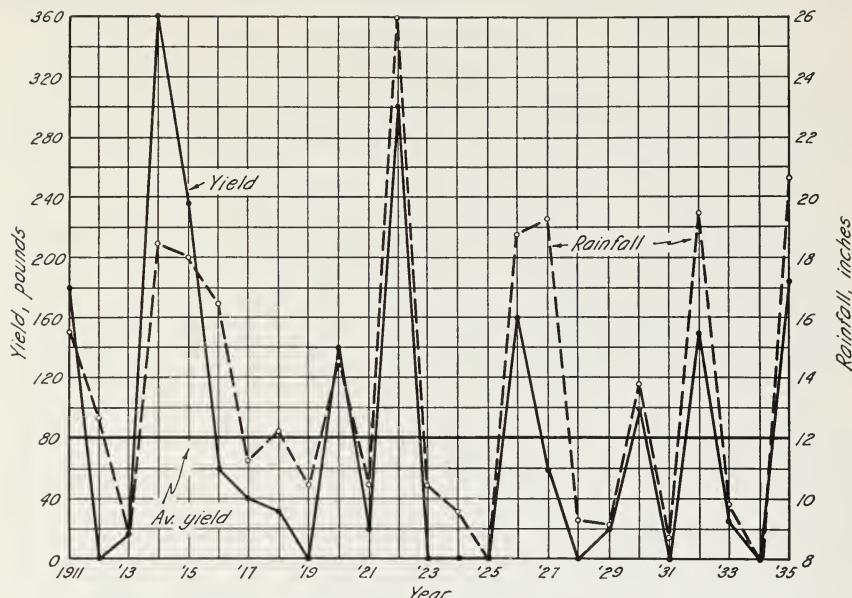


Fig. 16.—The effect of rainfall on colony yield. (Data by A. K. Whidden, Valley Center, California.)

two-story hives generally accumulate pollen in the lower brood chamber. If left with the second story full of honey, they will have sufficient stores to carry them through a long building-up period in the spring when additional stores are not available.

Weak or queenless colonies should be united, by the newspaper method, with queen-right colonies. Colonies below normal strength in the fall generally have poor queens. If sufficient bees are present to cover five or six frames of bees, and there is a young queen, the colony is usually strong enough to winter well in valley locations in California and to build up to normal strength in the spring.

Colonies well protected from the prevailing winds during the fall, winter, and spring will expend less energy in keeping warm. Below the snow line, colonies do not need more than wind protection during the winter period. Above this point their strength may be conserved by wrapping the hive in one thickness of building paper followed by a

thickness of tar paper on the outside and made watertight above. The entrances should be contracted to suit the colony size and guarded against mice.

All hive covers should be watertight and should be fastened or weighted down so that they will not be blown off during the winter. A good coat of paint applied to the hives every second or third fall keeps them in good order.

#### APIARY RECORDS

The majority of successful beekeepers keep certain records of factors which influence their colonies and such information becomes more valuable with the passing of time. For the beginner, records of the activities

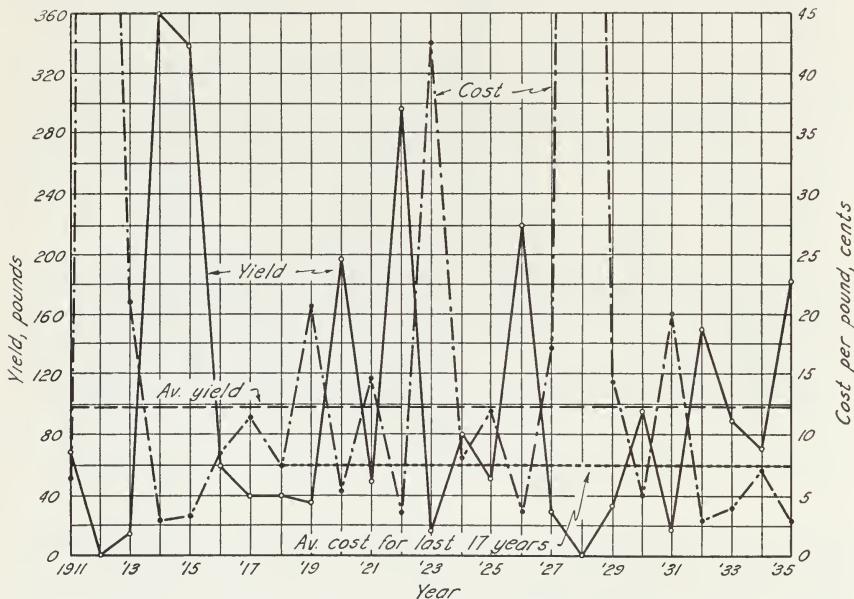


Fig. 17.—Cost per pound of honey in relation to colony yield.  
(Data by A. K. Whidden.)

of colonies during the year, correlated with weather and floral conditions, form a valuable source of information as a basis for study during the winter months in preparation for the next season's operations. Figures 16 and 17 were plotted from the records of Mr. A. K. Whidden, San Diego County apiarist, and represent data that are of invaluable importance to him in outlining his work in advance of any season. The figures apply to the section of the state in which he keeps bees and do not necessarily apply to other locations where climatic and floral conditions differ and where a different system of beekeeping may give better results.

It should also be stated that other factors not included in making these graphs, such as hours of sunshine, temperature conditions during

the honey flow, effect of colonies destroyed or injured by disease, etc. may have exerted considerable influence on the cost of production or total yield. In figuring his cost of production, Whidden included such items as his own salary, other labor, cost of gasoline and oil, depreciation on equipment, rent, interest on operating capital, etc. If the selling price was below the cost of production, he either had to borrow money to continue operations or received a very poor return for his labor.

#### MISCELLANEOUS MANIPULATIONS

*Moving Bees.*—Migratory beekeeping is an established practice in California because of the short duration of the average nectar flow and the long season when bees can fly actively. The many nectar sources available in various portions of the state also favor this type of beekeeping practice. Excellent roads in all sections and fast motor equipment permit a beekeeper to pick up 200 or more colonies at nightfall and carry them many miles within a short time. Migratory beekeeping is not simple, however; rather, it is hard work and in large-scale operations, requires expensive equipment.

When a colony is to be moved from one apiary to another, the different parts should be securely fastened together, and the bees confined to the hive by top and entrance screens. The top screens can be nailed on the hives while the bees are flying, and the entrance screens put on at the close of day when the bees are all in from the field. Figure 18 illustrates a good method of preparing a hive for moving. The top screen should be deep enough to provide ample clustering space during hot weather, whereas the entrance screen should permit bees to cluster between the screen and the front of the hive above the entrance. Because of the traffic on main-traveled roads and the antipathy of the average motorist toward bees that get into a car, bees should be securely confined during transport over the highway. Despite precautions in fastening up bees and in loading, some stray bees will cling to the outside of the hives. As these bees will be attracted to street lights if the truck pauses on the road, it is advisable to avoid stopping for gasoline and to detour around congested city streets.

Since bees orient themselves very carefully in relation to their surroundings, they will return to their former location unless taken out of the area where they have been accustomed to work. Colonies that are to be moved a few yards had best be changed only a few feet on successive days. Sometimes many bees will return to their former location when moved a mile and a half, and many may be lost if the entrances of their hives are not disguised by brush or weeds at the time of their first flight in

new surroundings; the field bees apparently fail to note the landmarks of their new location on leaving for the field the day after they are moved unless the entrances are blocked to prevent an uninterrupted flight.

*Uniting Colonies.*—When two colonies are to be united, the easiest method is to kill the poorer of the two queens and to set the queenless colony on a single thickness of newspaper placed over the one with which it is to be united. In hot weather the colonies should be united late in the afternoon, and one or two small holes punched through the paper. The bees will gnaw the paper into bits and carry it out of the hive. When this method is used, not many bees will return to their former location.



Fig. 18.—A two-story hive with moving screens in place. Note the staples fastening the parts of the hive together.

*Transferring Bees from Trees and Walls.*—Many inquiries are received from those who wish to kill or to transfer bees that have made their abode in trees or in the walls of buildings. Bees can be killed readily if exposed to the fumes of cyanogas; but this poison, being deadly to man and other animals, must be handled with care. The safest plan for any one not experienced with bees is to secure the services of a bee-keeper or the county apiary inspector. If the bees are confined to a comparatively small space, and the tree or wall cannot be opened economically, cyanogas is very effective. After killing the colony, seal the opening so that other bees cannot enter. The cyanogas generally becomes inert after 4 or 5 hours' exposure to air. Carbon monoxide fumes from the exhaust of an automobile can be used for a like purpose, and similar precautions should be taken to protect persons or pets.

An inexperienced person should not undertake to transfer a colony of bees from the walls of a house or from a box or tree because of the

danger of being seriously stung. Here, again, the services of a beekeeper should be solicited. One experienced in removing bees from such inaccessible places can control the bees while exposing their nest; then the combs can be cut away, the portions containing brood fastened into frames, with cotton string, and the bees enticed into the hive. Usually the hive must remain near the entrance to the wall or tree for a day or two after all traces of the combs have been removed from the cavity and the opening has been closed against the re-entrance of the same or other bees. With proper equipment and with patience, bees can be trapped from a wall or tree by means of a bee escape so arranged that they can leave but not re-enter. A frame of brood is generally necessary to cause the bees to accept the hive as their own. A queen should be introduced after a few days, and the hive left in position until the majority of the brood has emerged. Then the remainder of the bees in the cavity of the tree or wall should be killed, the entrance closed permanently, and the hive taken away.

#### QUEENS AND THEIR CARE

The welfare of a colony and the success of the beekeeper depend, for the most part, on the excellence of the queen and on thoughtfulness in her care. Good queens may be injured or killed by carelessness in manipulating frames or in introducing queens into colonies. The queen-breeders responsibility should not be taken lightly. Since the queen is almost as important to a colony as a foundation is to a house, her influence on production should be remembered whenever a hive is opened.

*Finding the Queen.*—Many beekeepers waste more time in finding the queen in a hive than the effort is worth. It is more important to recognize the work of a good queen than to find her on the combs. A proper amount of brood in all stages for the season of the year, regularly placed in the combs, indicates that the queen is functioning properly; and the colony need not be disturbed except to ascertain this fact by examining one or more frames of brood. But if the queen must be found the hive should be opened as quietly as possible and with no more smoke than necessary. Look for her on each brood comb as it is removed; and pay particular attention to combs containing eggs, for she will generally be found on one of them. If the hive is jarred or if too much smoke is used, the queen may hide or may run to the sides of the hive or the bottom-board, in which case she will be very difficult to find. As a last resort, shake the bees into a hive body and cause them to run through a queen excluder into a story below. The queen will be found on the excluder.

*Handling Queens.*—If a queen is to be marked, clipped, or lifted from the comb, she should be picked up by the wings with the thumb and fore-

finger of the right hand without pressure on her abdomen. If her wings are to be clipped, she should be transferred to the forefinger of the left hand, and at least two of her legs on one side grasped between that finger and the thumb and held firmly, but not too tightly. The queen will not sting when so handled, and reports of beekeepers being stung by queens are exceptionally rare. The queen can be marked and her wings clipped while held in this position. (The beginner may well practice on drones before clipping or marking his first queen.)

It is necessary to clip the queen's wings on only one side. Clip the wings for about one-half their length. Do not snip too closely, or mutilate a leg. If the left wings of queens are clipped one year and the right wings of new queens the next year, one can tell at a glance in what year a queen was produced.

A queen marked with a spot of bright yellow or vermillion on the top of her thorax is much easier to find than an unmarked queen, especially if she is a dark Italian, Carniolan, or Caucasian bee. Use a quick-drying paint containing a finely ground or liquid pigment. One part of white shellac to four parts of denatured alcohol with sufficient paint pigment to make a mixture the consistency of thin cream is satisfactory.

The queen can be run into a mailing cage without being caught by gradually "herding" her between the thumb and forefinger into the opening of the cage, which is placed next to the comb in front of her. Queens that have been confined to a mailing cage for some days are much smaller than when laying regularly and can fly readily if permitted.

*Introducing Queens.*—Until a beekeeper has had experience enough with bees to know how to rear his own queens, he should buy them from established queen breeders. Queens are generally listed as "tested" or "untested." No reliable breeder will knowingly sell a poor or an unmated queen; satisfactory service is his best advertisement. For this reason, most queens sold fall in the "untested" class but are satisfactory.

Colonies can be requeened at any time if proper precautions are taken to meet seasonal conditions; but most beekeepers introduce queens near the close of a honey flow or in the spring. As requeening can be combined with swarm control, the best time to requeen is generally conceded to be during the spring honey flow. If the spring season is short, with little time for the colony to build up for the main honey flow, as in the citrus regions of southern California, queens can be introduced after the orange-honey flow or in the fall.

Colonies should be made queenless at least a few hours before the new queens are introduced. This causes the colony to realize its condition and hence to accept a queen more readily. It is best to introduce the

queens before queen cells are started, or at least to tear down all queen cells at the time of introduction. Dequeening and requeening are often accomplished at the same operation. The old queen, if still active, may be set aside in a nucleus or put, without attendants, in a cage between

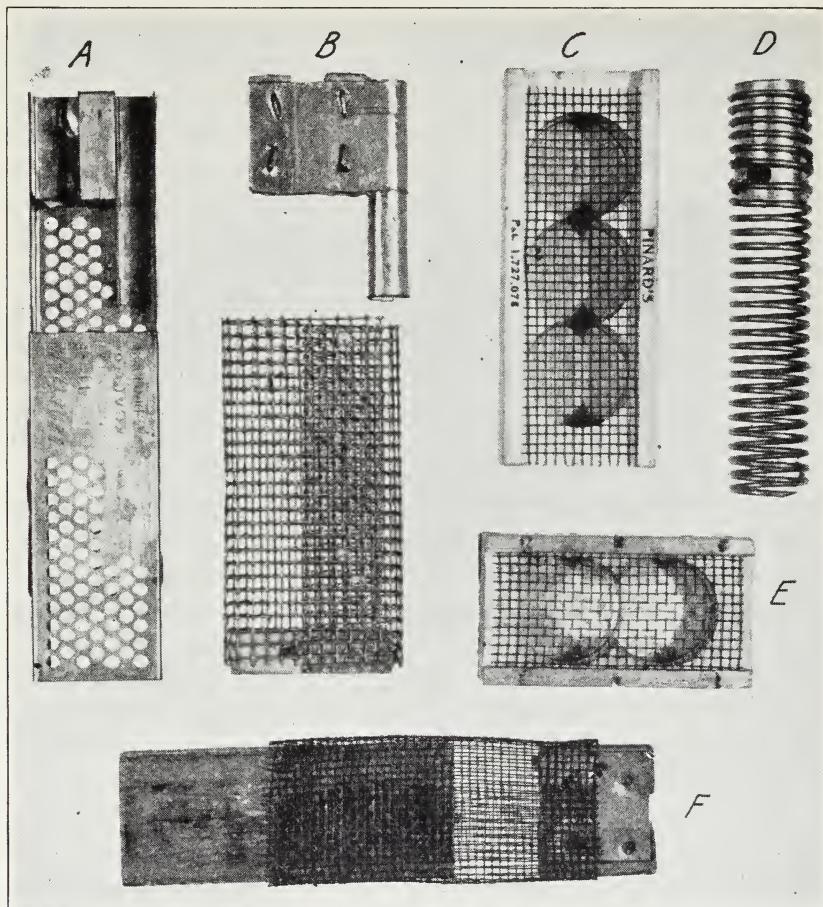


Fig. 19.—Types of cages used in introducing queens: *A*, "Ideal" introducing cage with a queen-excluding strip over the shorter food compartment; *B*, same principle as *A*, only homemade; *C*, nailless queen cage used as a mailing cage and introducing cage; *D*, Rauchfuss introducing and nursery cage; *E*, two-hole cage used in shipping queens without attendants or food in package-bee shipments; *F*, Miller introducing cage.

frames of brood above an excluder of some strong colony until the new queen has started to lay. If the queen is killed in introduction, the old queen can be reintroduced in the regular way.

Although there are several ways of introducing a queen, the majority of queens are introduced by means of the mailing cage (fig. 19). This

cage generally has three compartments, one being filled with soft candy which also fills a hole leading into this compartment from the outside. This hole is further covered with a small piece of pasteboard or a plug of soft paper. The address card should be taken from the top of the cage, but the paper covering the opening in the candy end of the cage should be left in place. (If the colony is small, this pasteboard may be removed with safety.) The cage can then be placed on top of the brood frames, wire side down, over the opening between two frames so that the bees can feed the queen through the wire and become "acquainted" with her. The bees will eat their way through the candy compartment, thus releasing the queen. If the hive is not equipped with an inner cover that can be inverted to take up the space occupied by the queen cage, then the cage should be placed between two frames of brood, with the candy compartment up, so that the bees can get to the wire of the cage. If the colony is in a two-story hive, the queen cage can be placed on top of the frames between the two stories. The hive should not be moved or disturbed for at least seven days after the queen is put in, because opening the hive before the queen has started to lay often results in her being injured or killed by balling.

Many successful beekeepers transfer the queen from her mailing cage to another in order to avoid introducing the attendant bees, which are almost equally hard to introduce. In this case the transfer should be made so that the queen cannot escape. Some queen-introducing cages have two exits, one shorter than the other but covered with queen-excluding zinc. Both exits are filled with queen-cage candy, and the bees eat out the shorter tunnel first and have access to the queen before she is released through the longer tunnel. Queens are generally accepted when introduced in these cages (fig. 19, A, B).

#### QUEEN-REARING

The importance of good queens cannot be overemphasized. In order to appreciate properly the amount of work involved in rearing them, every beekeeper should requeen some of his colonies with bees reared by his own efforts. To rear queens successfully on a commercial scale takes considerable equipment, special environmental conditions, and years of experience.

During the swarming season, under natural conditions, the queen will deposit an egg in one or more queen-cell cups; or the bees will build queen cells around young worker larvae, from which queens will be produced. These naturally-built queen cells can be cut from the comb and transferred to combs in other colonies or to queenless nuclei and

thus produce queens. This method is desirable only when the original queen is purely mated and fully satisfactory. Such cells are seldom produced except during the swarming season, and the practice of rearing queens from a swarming colony is questionable because the tendency to swarm may be accentuated by such selections.

*Rearing Queens in Artificial Cell-Cups.*—Instead of using naturally built cups, the commercial queen raiser makes his own by dipping molds into melted beeswax. The formed cells are then fastened to a bar with melted wax or are placed in small wooden cups, which, in turn,

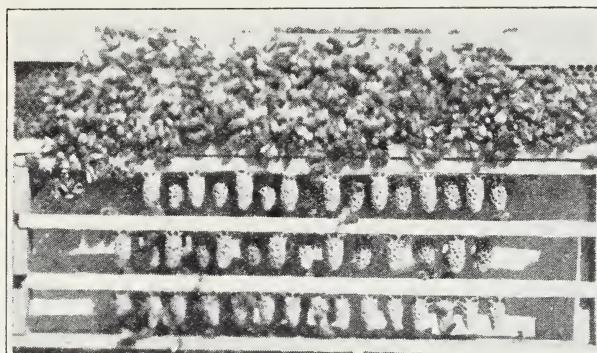


Fig. 20.—A frame holding 45 sealed queen cells produced by grafting larvae into artificial queen-cell cups.

are fastened to a bar with wax or a small tack. A Hoffman frame is modified to hold three or four of these bars, on each of which are fastened about 15 cell cups. A small drop of diluted royal jelly, taken from natural queen cells, about 3 days old and warmed to about 80° F., is placed in the bottom of each cell cup; and a young worker larva, 12 to 24 hours old, is transferred into each by means of a toothpick or grafting needle. The grafting should be done in a warm room free from drafts. The cell bars are then placed in the frame with the cells inverted, and the frame is given to a strong queenless colony previously prepared.

*The Cell-building Colony.*—For the purpose of getting a few cells built, a strong colony can be made queenless 24 hours before the cells are grafted. The colony should be strong enough to occupy two stories. One story, containing the queen and two or three frames of brood and bees, should be placed on a stand beside the old location; its entrance should be turned in the opposite direction from the original so that most of the bees will return to their former location. The rest of the brood and bees should be placed in the queenless portion, leaving space enough for the frame holding the cell bars. Such a colony will accept a majority of the cells given if the larvae were not injured when grafted. Twenty-

four hours after the cells are placed in this hive, the hive body containing the queen can be placed on its original stand, a queen excluder put on, and the body containing the queen cells placed over the excluder. Ten days after the larvae are grafted, the cells should be removed and placed in nuclei or colonies that have been queenless for at least one day. The young queens will emerge on about the twelfth day after grafting if 24-hour larvae were used.

The ripe queen cells (fig. 20) should be handled carefully, for injury to the developing bees will produce deformed queens. The bees adhering to the frame containing the cells should be brushed off, never shaken. Not more than fifteen cells should be given to a colony of this kind at a time; but a second and third bar of cells can be given at the end of the fourth and eighth days, respectively, after the first grafting. To insure proper development of the young queen larvae, the cell-building colony should be overflowing with bees, should have an ample supply of pollen, and should be fed, slowly but constantly, on sugar sirup.

The young queens will mate generally within 10 days after their emergence and will be ready to introduce into colonies a few days after they have started to lay. A young queen is often balled and injured if the nucleus or colony is disturbed before she has time to establish a brood area.

#### FEEDING BEES

Bees must be fed when they lack sufficient stores for their own maintenance. Colonies may be robbed too closely of their surplus stores; and when, for an unexpected or extended period, no nectar is available, artificial stores must be supplied. When nectar is scarce colonies may secure a quality of honey that will cause dysentery during long periods of winter confinement; then artificial food must be supplied late in the fall to offset these dire results. Under California conditions bees are not confined for long periods by cold or inclement weather. Colonies in high mountain locations can be moved to the valleys or foothills for the winter and spring.

Some beekeepers feed their colonies for extended periods between honey flows in order to maintain brood-rearing and colony strength. This practice is less common than formerly, most apiarists preferring to leave in the hives an abundance of honey sufficient for the most prolonged dearth and thus avoid the expensive and troublesome practice of feeding.

*Sugar Sirup.*—The best substitute for honey as a food for bees is a heavy sirup made of white granulated sugar and water. For winter stores the sirup should be made by dissolving 2 parts of sugar in 1 part of water. In feeding the colonies during cold weather, increase the ratio

of sugar to  $2\frac{1}{2}$  parts to 1 part of water, adding 1 teaspoonful of tartaric acid to every 20 pounds of sugar to keep the sirup from granulating. In making this heavy sirup, use boiling water to dissolve the sugar, and add the tartaric acid to the boiling sirup. Stir constantly until all sugar is dissolved. Sugar sirup that has fermented, especially in tin or galvanized containers, should not be fed to bees, for it often poisons them.

*Method and Time of Feeding.*—There are many systems of feeding colonies on sugar sirup; entrance feeders, open-pan feeders, division-board feeders, the splash system, open-air floats, and the like; but the type of container most used in recent years is the 5 or 10-pound friction-top pail. The lid is punctured from the inside with a number of holes made by a three-penny wire nail, the number of holes, as well as the strength of the colony, determining the speed with which the pail is emptied by the bees. For slow feeding only one or two holes are needed; but for winter feeding twenty to thirty holes. The pails are filled with the sirup and inverted over the bee-escape hole of the inner cover or directly on top of the frames. If the pail is inverted directly on top of the frames in cool weather, the frames should be covered with a cloth to preserve heat. A still better method in cool weather is to cut a hole in a burlap sack, place it over the frames, and invert the pail over the hole. In all cases, an empty hive body must be placed around the feeder.

If apiaries are so isolated that open-air feeders can be used, the feeders should be located some distance from the apiary in order to reduce robbing. The sirup can be poured in open pans, trays, or troughs, and suitable floats provided to prevent drowning. The stronger colonies will, of course, secure the most sirup. Obviously, this is a "charitable" method of feeding if other colonies are within flying distance.

To avoid robbing in an apiary, colonies should be fed late in the afternoon so that the bees will have lost by morning much of the excitement incident to acquiring the sirup. Best results are secured from stimulative feeding if the colony secures a small amount of sirup continuously over a long period. For this purpose friction-top pails can be used if the lids are perforated with only two to four holes; they will not leak if the pail is level. Colonies being fed for winter stores should receive the sirup after the close of brood-rearing so that brood-rearing will not be unnecessarily prolonged.

*Pollen Substitutes.*—There is no substitute food known comparable to pollen in the diet of the colony. Bees cannot rear brood successfully on sugar sirup alone. In regions where there are occasional shortages of pollen, needy colonies should be moved to new locations where pollen is

available; or combs of pollen should be stored for just such emergencies and given in time of need. Although bran, rye meal, grain flours, milk, egg white, dried yeast, and other substitutes for pollen have been tried with some success biologically, they are not suitable economically.

#### DISEASES OF BEES

The honeybee, like most other animals, is subject to diseases and enemies, which continually menace its survival. In territories with no organized methods of control, brood diseases in particular may make beekeeping precarious or impossible. Fortunately, such a condition no longer exists in the more important beekeeping regions of California, where county inspection of apiaries has been in force for several years. The very destructiveness of the different diseases, however, and the uncertainty of entirely eradicating them from any particular territory, compel every beekeeper to study the more important diseases, their methods of spread, and their control.

The diseases may be divided into two classes: those affecting the brood and those attacking the adults. The former are generally more serious and more difficult to control than the latter, except, possibly, the Isle of Wight disease, which does not occur in this country. Brood diseases are usually specific in character and can be distinguished by their gross and microscopical symptoms. As some cause offensive odors, they are generally called foulbrood; but this term more rightly applies to two of worldwide distribution, American and European foulbrood.

*American Foulbrood.*—This disease is by far the most destructive and most generally distributed brood disease. Once attacked, a colony seldom recovers. The disease is persistent. It is caused by a spore-forming bacterium, *Bacillus larvae*, that attacks the larvae shortly before or after the cells are sealed. For this reason the beekeeper seldom discovers the disease until occasional cells of sealed brood have sunken, greasy-looking cappings, often with irregular perforations. The dead larvae vary from brownish yellow to brownish black, according to the degree of putrefaction; they are always stretched lengthwise of the cell and retain their shape for only a few days after death. Near the final stages of decay they lose all traces of segmentation and become a flattened mass, the contents of which are tenacious or ropy. If, at this stage, a match stem or straw is used to stir the contents of a diseased cell and then slowly withdrawn, the decayed material will rope for a distance of 1 to 4 inches before breaking. The offensive odor reminds one of heated glue. The final remains or scale of the larva usually adheres to the lower side and bottom of the cell too tightly to be removed by the bees unless the

cell wall is torn down. In advanced cases pupae are also killed; remains will be found with the pupal tongue extending upward, sometimes attached to the top of the cell. Most cells containing these scales are uncapped entirely by the bees. The disease attacks the worker brood primarily, rarely drone or queen larvae.

The spores of *Bacillus larvae* can survive in honey for an indefinite period. For this reason this disease is spread primarily by bees robbing honey from diseased combs and by the use and interchange of diseased equipment. There is no concrete evidence that any strains of bees have built up an immunity during the centuries in which American foulbrood has been recorded. The differences sometimes noted in the seriousness of this disease in various places or in the same apiary are as logically due to a lack of virulence of the organism causing the disease or to an absence of suitable environmental factors for its rapid spread as to immunity on the part of the bees. For these reasons the disease should not be tolerated or experimented with by novices or commercial bee-keepers. It is illegal in California to keep or to move colonies thus infected.

Various methods tried in the control of American foulbrood have been based on the fact that the disease can be transmitted by honey from diseased colonies and that usually the scales cannot be removed from the combs by the bees. The bacillus causing the disease is also highly resistant to drying. Attempts have been made to save the bees by shaking them from a diseased hive onto frames containing sheets of foundation; but this practice often causes the disease to be spread through robbing and by bees drifting from the diseased colony during the procedure. Consequently, the most effective treatment is to kill the colony and to destroy all the diseased combs and their frames.

The most practicable method of killing the colony is to place a tablespoonful of powdered calcium cyanide (cyanogas) on the bottom-board 2 or 3 inches behind the entrance at nightfall. This deadly poison should be handled with extreme care so that the fumes will not be inhaled by the operator. After killing the bees, carry the hive to one side of the apiary, and burn all combs and bees in a hole large enough to keep any honey or wax from running out on the ground. Kindling and kerosene make a quick, hot fire. The bottom-board, hive bodies, and covers can be saved but should be scraped clean and disinfected by charring lightly with a blowtorch. After the fire has burned out, the hole should be covered to a depth of 18 inches with soil.

*European Foulbrood*.—This form of brood disease attacks the larva still coiled in the bottom of the cell, generally at a very early stage. The

infected larva first assumes a light-yellow color, loses its well-rounded appearance, and becomes so translucent that the tracheae can be seen through the body wall. As the disease progresses in the colony, older larvae are attacked until a small percentage of the diseased larvae are in sealed cells. The dead larvae are generally found in almost any position in the cell—on the sides, on the bottom, or near the front. The final scale formed is removable from the cell by the bees. The ropiness of the decayed larval remains is less noticeable than in American foulbrood; often no ropiness can be found.

European foulbrood is caused by a bacterium known as *Bacillus alvei*. *Bacillus pluton*, once held as the primary cause, is now considered to be a stage in the life cycle of *B. alvei*. Because of its somewhat complicated life history and also because of secondary invading organisms, the gross symptoms of European foulbrood vary considerably and are sometimes confused with certain stages of American foulbrood.

This disease does not occur in all sections of California, being associated, apparently, with weak colonies and the absence of an early spring nectar flow. Usually it does not occur until the second or third cycle of brood in the spring; then it gradually weakens the colony until the number of bees is insufficient to store a maximum amount of honey. The disease may disappear with the beginning of a honey flow or may continue in somewhat abated form throughout the season.

Before the introduction of Italian bees into the United States, European foulbrood was very destructive to the German blacks that were commonly used. Strong colonies of Italian bees are generally immune; but under adverse circumstances even colonies of Italians are sometimes reduced by its inroads. Beekeepers, in fact, commonly state that this disease does not "play fair" but appears when least expected, often in epidemic proportions.

Since the bees are able to remove the diseased material, treatment is based on at least three fundamentals: strengthening the diseased colonies by uniting two or more colonies, if necessary; dequeening for a time to break the brood-rearing cycle, in order to give the bees time to clean diseased material from the cells; and requeening with a resistant strain. If the colony is strong, the queen should be killed, and a ripe queen cell or a virgin queen from a resistant strain of bees given as soon as the colony has discovered its queenlessness. If a nectar flow is in progress, this treatment will generally be effective. If no nectar is available, it may be necessary to allow a queenless period of 10 days, after which the colony can be requeened in the manner described above. Feeding to stimulate brood rearing aids in the control of this disease.

*Para Foulbrood*.—In 1930 a disease was discovered in Georgia and Florida that had different symptoms from all known diseases. Subsequently, it was found in North and South Carolina. Although it has not been noticed in California, every beekeeper should know its symptoms, and be ever on the watch for it. Detailed symptoms are discussed in the newer editions of standard works on bee diseases.

*Sacbrood*.—Occasionally one will find in a colony a few or many cells containing dead larvae that have symptoms different from those described for the other diseases. The larvae are generally attacked in the late larval or pupal stages, as in American foulbrood, and so are found primarily in sealed cells or in cells that have been uncapped by the bees. The skin of the diseased larva remains intact and does not adhere to the cell wall. The body contents are watery and flow to the posterior portion of the larva when it is held in a vertical position outside of the cell, thus giving rise to the name sacbrood. The dead larva remains with the dorsal side along the lower wall, the head lying outward and extending upward. The tip of the head is generally black, while the rest of the body varies from gray to brown. The disease is mildly infectious and is caused by a virus. Though it sometimes reduces the strength of a colony, it is seldom serious. No definite treatment is recommended. Since some strains of bees seem more susceptible to sacbrood than others, one should change to queens of a different strain whenever the disease becomes prevalent.

*Chilled or Starved Brood*.—Sometimes in early spring a colony will expand its brood area beyond its ability to keep the brood warm during a sudden cold spell. If the cluster is forced to contract, the exposed larvae may die of chilling or starvation. Such conditions should clear up quickly and are generally distinguishable from the symptoms of the diseases just described.

*Poisoned Brood*.—In areas where large quantities of poisons are applied to growing crops for the control of insect pests, and particularly where the poisons are permitted to be broadcast by airplane, bees may secure sufficient poison on pollen to cause the death of nurse bees and larvae. Usually the poisoned larvae die in all stages, and the trouble may be confused at first with European foulbrood. Poisoned brood generally occurs all at once and may be present over an extended period. In cases of the poisoning of bees, the nectar gatherers die in the field. A chemical analysis of the dead larvae and adult bees will indicate the presence of the poison.

*Dead Drone Brood in Worker Cells*.—Whenever a colony becomes hopelessly queenless and the worker bees assume the egg-laying habit, many of the resulting larvae are neglected and allowed to die. This con-

dition should be recognized readily because of the great amount of drone brood in worker cells at the time.

*Nosema Disease*.—This disease is caused by a protozoan, *Nosema apis* (Zander), that attacks the epithelial lining of the mid-intestine, ultimately killing the adult so attacked. Little is known of its life history outside the honeybee or of its method of spread. Although it generally does not destroy a colony, it may reduce colony strength considerably. It is most common during the late spring period in California and usually disappears with settled warm weather. Bees affected with this parasite are often found in numbers in front of a hive, where many will be trembling and crawling somewhat aimlessly about. Many others will remain within the colony, badly affected. Often the wings become disjointed. In the later stages of infection, the bees are unable to fly, and the dead may gather in quantities for some distance before the entrance.

Destruction of the dead bees should be practiced in all cases, and raking the ground around the hive may also decrease the possibility of infection from the soil. Since some colonies appear less susceptible than others, a change in strain of bees might be advisable.

*Paralysis*.—Very little is known of the cause of this disease, nor have the symptoms been sufficiently defined for any particular ailment of the adult bee to be assigned to paralysis. Beekeepers tend, in fact, to call practically any and every adult bee ailment paralysis. Paralytic bees may become almost devoid of hair; they appear shiny and greasy. Their bodies are sometimes swollen with fecal material, and the bees shake and shiver. Their wings are often flattened and disjointed, and such bees are to be found before the entrances and on the bottom-boards and combs of the hives affected. The lighter strains of Italians appear more susceptible to paralysis than the darker strains. The disease seldom kills a colony but may reduce its numerical strength till the amount of surplus stored is greatly curtailed.

No positive cure is known. Sanitation and requeening with healthy stock will usually prevent serious reoccurrences.

*Chemical Poisoning*.—Honeybees are very susceptible to all stomach poisons, such as the arsenates, fluosilicates, nicotine (although tobacco fumes act as a repellent), paris green, thallium, and rotenone. Even such a small quantity of arsenate as one-half part per million will cause the affected bee to leave the hive or to lose the power of muscular coördination. The use of powdered poisons in controlling insect pests, especially when, as in airplane dusting, the poison is not confined to the treated field, is particularly dangerous. In airplane dusting at least 50 per cent of the poisons drift for great distances, poisoning all vegetation with

which they come in contact. Poison clouds may travel at least 3 miles and at that distance will still be sufficiently concentrated to kill bees feeding on the nectar of flowers where poison falls.

The bees gathering poisoned nectar die in the field, while the pollen bearers carry back to the hive with the pollen sufficient poison to kill the nurse bees and the larvae. Since chemical poisoning of this type menaces the welfare of beekeeping more than all the diseases put together, the beginner should choose his territory carefully until the practice of applying poisons to growing crops is properly regulated.

Where bees work on the crop treated, such as peas, beans, cantaloupes, watermelons, and fruit blossoms, or on covercrops where the poison may fall, and where the methods of insect control confine the poison to the crops treated, the owner should move his bees out of the area in order to prevent loss. Farmers whose crops are improved both in quality and quantity by the activities of the honeybee in properly pollinating the blossoms should be glad to give notice when they intend to apply the poisons and should do what they can, consistent with their own interests, to safeguard the bees.

*Plant Poisoning.*—The nectar or pollen of a very small number of plants causes intestinal, reproductive, or metabolic disturbances in the honeybee. In this state the California buckeye (*Aesculus californica*) and *Veratrum* (corn lily) are known to produce pollen or nectar injurious to the adult or larval stages of the honeybee. Loco weed is also suspected. The California buckeye is the most noted plant of this type. It is particularly injurious in dry years and in locations where it is abundant. In the foothills, up to 4,500 feet elevation, surrounding the Great Valley of California, beekeeping is extremely hazardous while this plant is in bloom.

The first deleterious effects of buckeye pollen or nectar on the honeybee are noted within 7 to 10 days after the bees have started work on the blossoms. The brood becomes irregular in appearance because of the death of many young larvae. The egg-laying rate of the queen is greatly reduced; and after a few weeks an increasing number of her eggs do not hatch, or a majority of the young larvae die within 3 days after hatching. Some larvae produce adults with crippled wings or malformed legs and bodies. The queen may cease laying entirely or become a drone layer. At times the combs are devoid of brood except in the egg stage, and many of the eggs appear shriveled. The malformed bees crawl out of the hive and the dead pile up in front of the entrance. Some of the field bees show symptoms of paralysis; bees with black, shiny bodies are common. After a few weeks the colony becomes greatly weakened or dies.

If a colony is removed from the buckeye location, the queen may resume laying in a fairly normal manner. The effects of the poisoning, however, are evidenced as long as the buckeye pollen remains in the combs.

Honey produced from the California buckeye is edible and produces no harmful effects when used for human food. In fact, no poisonous honey has ever been found in California; and this statement applies generally to other sections of the United States.

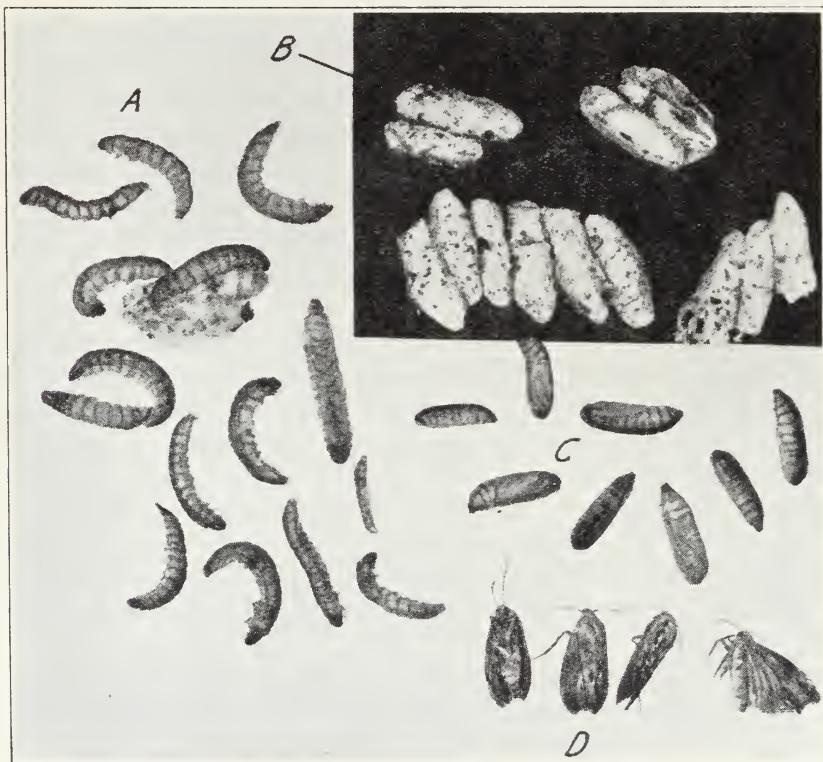


Fig. 21.—Forms of the greater wax moth: *A*, larvae; *B*, pupal cases, or cocoons; *C*, pupae removed from their cocoons; *D*, adults.

#### ENEMIES OF BEES

*The Wax Moth.*—The larval forms of the greater wax moth (*Galleria melonella*) (fig. 21) destroy combs by burrowing through the cells, constructing silken tunnels as they go. The larvae feed on the pollen and waste materials found in the cells and spot their tunnels with excreta. The adult female deposits her eggs in small crevices about the hive, generally after dark, and commonly lays from 400 to 800 eggs. The eggs

hatch within 5 days or more, according to the temperature; and the larvae become ravenous feeders, reducing a comb to a mass of webs and waste material within a short time (fig. 22). After the feeding period, the larvae spin their pupa cases in the comb or migrate to the frames or walls of the hive and there eat a depression in the wood before spinning their cocoons. In California, with favorable food and temperature conditions, two or more generations may be produced within a single season.

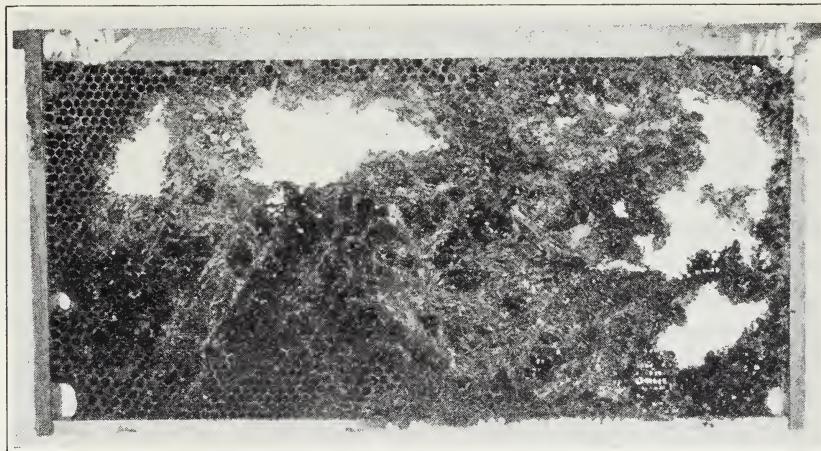


Fig. 22.—Comb riddled by wax-moth larvae. Note the cocoons on the top bar.

Although combs in strong colonies of Italian bees are seldom affected by this pest, storage combs are soon destroyed unless properly protected. Combs in weakened colonies are likewise attacked, but the weakened condition is seldom the cause; on the contrary, the wax moths are generally the "pall bearers" which clean up the combs after the colony dies.

Storage combs can be protected by being kept in an airtight room and fumigated with burning sulfur. To make doubly sure that all larvae are killed, fumigate the combs twice, 10 days apart, to kill any larvae that may hatch after the first fumigation. If combs are left in strong colonies until cold weather, fumigated, and then stored in a cool place, there will be little danger of injury from wax moths during the winter.

Paradichlorobenzene, or "Paracide," will repel the wax moths and kill their larvae. This chemical can be placed upon a piece of paper over each super of combs as the combs are stacked for storage. About a tablespoonful per super will suffice if the supers are made airtight.

*Other Insects Attacking Comb.*—The lesser wax moth (*Achroia grisella*) is probably not present in California. The Mediterranean flour-moth (*Ephestia kuhniella*) and the Indian meal-moth (*Plodia inter-*

*punctella*) sometimes attack the pollen of combs in storage, the larvae feeding on the pollen but not destroying the combs. The silken webs, confined primarily to the individual cells, are easily distinguished from the silken tunnels of the wax moth. These larvae work at lower temperatures than wax-moth larvae but can be controlled by the same methods.

*Mice*.—Mice may be very destructive to combs in storage or on the hive in winter. Combs both on or off the hive should be protected from their depredations. Mice cannot injure the combs of a colony if a queen excluder is placed between the brood chamber and the bottom-board during the fall and winter.

*Skunks*.—This animal, although usually beneficial, may become a serious pest in an apiary during the dry seasons when other food is scarce. Skunks visit the hives at night, scratch in the dirt in front of the hive or at the entrance, and eat the bees that investigate the disturbance.

*Bears*.—Many reports have been received of the destruction of bee equipment by bears in mountain locations. Bears are very fond of the brood of bees, as well as the honey, and often destroy small apiaries in unprotected places.

*Miscellaneous Pests*.—Toads, birds, dragonflies, ants, spiders, yellow jackets, and other enemies prey on bees and under certain conditions may seriously decimate a colony. The amount of injury varies in different locations, and remedies can be applied according to the nature of the trouble. In some cases it may be advisable to move colonies to more favorable locations.

#### APIARY INSPECTION

The California Apiary Inspection Act of 1927, with its subsequent amendments, deals with the control and eradication of bee diseases in California. It pertains particularly to foulbrood diseases. Its enforcement is directed by the State Director of Agriculture through the offices of the State Apiary Inspector, the County Agricultural Commissioners, and their deputies. Practically every county in California in which bee-keeping is recognized as an important agricultural industry has the apiary-inspection service.

In 1935 the following counties had one or more apiary inspectors: Alameda, Butte, Colusa, Contra Costa, El Dorado, Fresno, Glenn, Imperial, Kern, Kings, Lassen, Los Angeles, Madera, Merced, Modoc, Monterey, Orange, Riverside, Sacramento, San Bernardino, San Diego, San Joaquin, Shasta, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tehama, Tulare, Ventura, Yolo, and Yuba. In the remaining counties, beekeepers can secure apiary inspection by applying to the State Apiary Inspector, State Department of Agriculture, Sacramento.

Beekeepers can do much to eradicate bee diseases by inspecting their own colonies frequently and by obeying the regulatory measures as to the registration and moving of hives and used equipment. According to the laws of this state, every beekeeper on or before the first day of March each year must register with the agricultural commissioner the number of his colonies and their location. It is unlawful for any person to move bees within the state unless he first obtains from the county inspector a certificate certifying that such bees have been inspected and found free from disease. When origin and destination are registered, seasonal-locations notice to inspectors only shall be required. It is also unlawful for any person owning or controlling bees, hives, or appliances within the state, infected with disease, to move or transport the same except upon written permission of the inspector, or to sell diseased bees, hives, or appliances. The state or county inspector is always ready to aid the beekeeper in disease control. In case of doubt concerning the gross symptoms of any disease, consult the county inspector; or send a sample of the diseased brood to the State Department of Agriculture in Sacramento for diagnosis. A copy of the Apiary Inspection Act can be secured from the same department.

#### SOME FACTS ABOUT HONEY

Honey is the sweet, viscid secretion gathered and elaborated by bees from the nectaries of flowers and stored in their combs for food. Honey is primarily a carbohydrate food, consisting principally of a solution of two invert sugars, dextrose, and levulose. Its moisture content is generally less than 20 per cent; and it contains, besides the two sugars mentioned, a small quantity of sucrose (never more than 8 per cent), aromatic bodies, minerals, enzymes, pigments, acids, and other components as given in the following tabulations:<sup>4</sup>

	Per cent	Grams	Ounces
Water . . . . .	17.7	128.3	4.5
Dextrose (grape sugar) . . . . .	34.0	246.6	8.6
Levulose (fruit sugar) . . . . .	40.5	293.6	10.2
Sucrose (cane sugar) . . . . .	1.9	13.7	0.8
Dextrins and gums . . . . .	1.5	10.9	0.3
Ash (silica, iron, copper, manganese, chlorine, calcium, potassium, sodium, phosphorus, sulfur, aluminum, magnesium) .	0.18	1.305	0.04
 Total. . . . .	95.78	694.4	24.44

<sup>4</sup> These data were prepared by the United States Department of Agriculture for the American Honey Institute. The calculations are based on samples of 500 cubic centimeters; total weight 725 grams (25.6 ounces).

The following substances also occur in relatively small quantities; they total 4.1 per cent, or 30.3 grams, or 1.0 ounce:

- Acids (formic, acetic, malic, citric, succinic, amino)
- Pollen grains
- Beeswax
- Pigments (carotin, xanthophyll)
- Albuminoids (proteins)
- Chlorophyll decomposition products.

There is still a third group of known substances occurring in honey but difficult to demonstrate quantitatively. They are therefore only enumerated, as follows:

- Enzymes {
  - Invertase (converts sucrose to dextrose and levulose)
  - Diastase (converts starch to maltose)
  - Catalase (decomposes hydrogen peroxide)
  - Inulase (converts inulin to levulose)
- Aromatic bodies (terpenes, aldehydes, esters)
- Higher alcohols (mannitol, dulcitol, etc.)
- Maltose, rare sugars (sometimes melezitose, etc.)

The chemical and physical properties of a honey depend chiefly on its floral source but are influenced by such factors as climatic and soil conditions, altitude, method of production, and preparation for market. Although the honeybee generally works on only one source at a time, a colony may gather nectar from two or more sources before the surplus is extracted by the beekeeper, thus producing a natural blend of two or more distinct flavors.

Honey is generally sold in the liquid form or in the comb, as section or chunk honey; but an increasing demand is being developed for the granular form as well. When the crystals of granulated honey are very small, it is preferred by many. Liquid honey will granulate fairly rapidly if a quantity of finely granulated honey (about 5 per cent) is thoroughly mixed with it, and the product stored in a cool place (57° F.). The speed of normal granulation in honey apparently depends upon the levulose-dextrose ratio. Sage honey, high in levulose, will remain liquid for years without any trace of granulation. If it is blended with a honey that granulates readily, orange honey for example, the blend will also granulate.

*Effect of Heat on Honey.*—Granulated honey can be liquefied by heating in a double boiler or water-jacketed container. Honey darkens in color and loses some of its aroma when held at a high temperature. Generally a temperature of 145° to 160° F. for one hour will cause little change in its color or flavor, and this heat is suitable for all purposes of straining or liquefying. Honey heated in this manner, bottled or canned while hot, and then cooled quickly will remain liquid longer than if unheated.

*Dietetic Value and Uses.*—Honey deserves a preferred place among sweets because the sugars, being in invert form, are readily assimilated. The presence of minerals, although in minute quantities, adds further to its desirability as a food. Honey also has incomparable flavor and sweetness that tend to satisfy the craving for sweets without the ingestion of large quantities of sugar. The slightly laxative effect of honey, when used to modify cow's milk in infant feeding, is considered to be of great value.

The comparative caloric value of honey and various sweetenings is given as follows:<sup>5</sup>

Material	100-calorie portion measure	Weight, ounces	Total calories	Distribution of calories		
				Protein	Fat	Carbohydrates
Corn sirup.....	1¾ tbsp.	1.0	100	...	...	100
Corn sirup.....	1 tbsp.	0.6	56	...	...	56
<i>Honey</i> .....	1 tbsp.	1.1	100	1	...	99
Maple sugar.....	piece 1¾" x 1¼" x 1½"	1.1	100	...	...	100
Maple sirup.....	1½ tbsp.	1.2	100	...	...	100
Molasses.....	1½ tbsp.	1.2	100	3	...	97
Molasses.....	1 tbsp.	0.8	65	2	...	63
Molasses.....	1 cup	10.0	815	27	...	788
Sugar, brown.....	3 tbsp.	0.9	100	...	...	100
Sugar, brown.....	1 cup	5.8	625	...	...	625
Sugar, granulated.....	2 tbsp. (scant)	0.9	100	...	...	100
Sugar, granulated.....	1 cup	7.4	840	...	...	840
Sugar, loaf.....	4 pieces 1½" x ¾" x ¾"	0.9	100	...	...	100
Sugar, powdered.....	2¾ tbsp.	0.9	100	...	...	100
Sugar, powdered.....	1 cup.....	6.0	680	...	...	680

In other words, 1 tablespoon of honey based on caloric value is equal to 1¾ tablespoons corn sirup, 4 tablespoons maple sugar, 1½ tablespoons molasses. The above data concern only the calories within given portions of various types of sugars. Honey has about 50 per cent more sweetening value than the best cane molasses. The best grade cane sirup contains about 30 per cent of water, while honey contains 17 per cent water.

Honey adds flavor as well as sweetness to any food to which it is added. A cup of honey weighs 12 ounces, 9¼ ounces of which is sugar. (A cup of granulated sugar weighs 7 ounces.) So in substituting honey for sugar in cakes or cookies, these three factors—flavor, extra sweetness, and moisture—should be considered. A cup of honey contains liquid to the equivalent of three tablespoons and one teaspoonful. Honey is also hygroscopic and keeps cookies and cakes moist over a long period.

In addition to its use in cookies, cakes, and breads, honey is used as a spread on bread, toast, biscuits, cakes, and waffles; it is also used as sweetening for cereals, fruits, salads, and in making candies. It also enters into many medicinal formulas, skin lotions, beauty creams, and into the making of honey vinegar and honey wine, or mead.

<sup>5</sup> These figures are taken from: Rose, Mary Swartz. Feeding the family. 3rd ed. xvii + 459 p. 1929.

*Cause of Fermentation in Honey.*—Practically all honeys contain sugar-tolerant yeasts, derived chiefly from the nectar and pollen of flowers. Honeys that are not well ripened in the hive before being extracted contain a higher moisture content and are therefore more readily attacked by the action of yeasts.

Honey is generally considered to keep indefinitely, but recent investigations indicate this idea to be correct only when honey is stored at 50° F or below. At this temperature the sugar-tolerant yeasts are practically inactive. At temperatures around 60° F granulated honey in particular is subject to fermentation. This phenomenon is brought about by the fact that in granulation some water is thrown out in the formation of the dextrose crystals. This free water raises the total amount of water in the liquid phase surrounding the dextrose crystals to the point where fermentation will proceed more rapidly. A temperature of 60° F favors crystallization as well as fermentation, whereas 80° F is said to be less favorable to both changes. Evidently, then, fermentation is tied up rather closely with granulation, moisture content, and temperature.

*Preventing Fermentation.*—Honey should be extracted only when well ripened in the comb to assure a low moisture content. Yeasts in honey are killed by a temperature of 160° F, and honey heated to this point will not ferment if kept in airtight containers. Honey will give off moisture in a dry, warm atmosphere but will absorb moisture under humid conditions.

#### HONEY FROM HONEYDEW

Honeydew is the sweet viscid excretion of plant-sucking insects, such as plant lice (Aphidae) and scale insects (Coccidae). These insects eject that portion of the plant juice or sap they cannot utilize in the form of a sweet liquid, attractive to bees when sources of nectar are not available. These juices are gathered and elaborated by bees in the same manner as nectar.

Honeydew honey varies from water white to very dark in color. It is usually more viscid than honey from a floral source, contains a lower percentage of invert sugars, and is higher in dextrins. It is rather variable in flavor, being suitable primarily for the bakery trade rather than for table use. In some years honeydew is more plentiful than at other times and is produced in such quantities as to cover the leaves of trees and the ground beneath. In such seasons colonies have been reported to gather from 100 to 300 pounds of honey from this source. It usually sells at a lower price than floral honey.

### **MARKETING HONEY**

The commercial beekeeper generally places his extracted honey in 60-pound tins after it has been strained and clarified in tanks. It is then ready for sale to the wholesale buyer or honey bottler. The price is generally lower at extracting time than at any other period of the year because so much honey is then available. Consequently, an increasing number of beekeepers are placing their honey in bonded warehouses and holding it for a more favorable market. The warehouse receipt can be used to secure a loan if needed. This system promotes orderly marketing and insures the producer a greater return for his labor.

Honey is sold in retail packages of glass or tin the same as any other food product. An increasing amount of honey is being dispensed at roadside stands and by the producer selling from house to house. In all such methods the price should conform generally with the retail prices of the community and be consistent with the labor and expense involved. All containers and labels should be new and clean and should in all respects conform with the state regulations and standards. Many beekeepers can dispose of their entire crop from a roadside stand at retail prices when they are located on a well-traveled highway. The 5-pound friction-top pail is a very popular container as the cost per pound for packaging is less than when honey is sold in smaller quantities in glass.

### **BEEKEEPERS' ORGANIZATIONS**

The beekeepers of many counties in California have formed county organizations and hold periodic meetings in order to exchange ideas of mutual interest in the practice of beekeeping. These organizations and their members are affiliated with the California State Beekeepers Association which was organized in Los Angeles on January 7, 1892. Besides these organizations there is the Southern California Bee-Men Club and the California Bee Breeders Association. The American Honey Producers League and the American Honey Institute are national organizations in which many California beekeepers are members.

It is advisable for every beekeeper to belong to his county and state associations in order to have a medium for the exchange of ideas and to benefit by educational programs designed for the good of the industry. These associations may become affiliated with the national organizations for the promotion of the affairs of the industry on a national basis. The American Honey Institute serves as a honey-research center and a medium for dissemination of honey publicity for the purpose of increasing the consumption of honey.

**REFERENCES FOR FURTHER READING**

The various state agricultural colleges and the United States Department of Agriculture will furnish, upon request, lists of their available publications. Every beekeeper interested in keeping in touch with the current developments in the industry should subscribe to one or more bee journals. Many of the books listed below are obtainable through local libraries or through the bee journals. They contain information that will be helpful and interesting to the commercial beekeeper as well as to the novice and should be consulted freely.

**Periodicals**

- American Bee Journal*, Hamilton, Illinois.  
*Bees and Honey*, Alhambra, California.  
*Beekeepers Item*, San Antonio, Texas.  
*Gleanings in Bee Culture*, Medina, Ohio.

**Books**

- DADANT, C. P.  
1922. Langstroth on the hive and honeybee. 438 p. *American Bee Journal*, Hamilton, Illinois.
- ESSIG, E. O.  
1931. A history of entomology. p. 265-273. The Macmillan Co., New York City.
- HARBISON, J. S.  
1861. The beekeepers directory or the theory and practice of bee culture. 440 p.  
H. H. Bancroft and Company, San Francisco, California. (Out of print.)
- LOVELL, J. H.  
1926. Honey plants of North America. 408 p. A. I. Root Company, Medina, Ohio.
- PELLETT, FRANK G.  
1918. Productive beekeeping. 302 p. J. B. Lippincott Co., Philadelphia, Pa.  
1920. American honey plants. 297 p. *American Bee Journal*, Hamilton, Illinois.
- PHILLIPS, E. F.  
1929. Beekeeping. 490 p. The Macmillan Company, New York City.
- ROOT, A. I., and E. R. ROOT.  
1935. ABC and XYZ of bee culture. 815 p. A. I. Root Company, Medina, Ohio.  
(This is a profusely illustrated and well written encyclopedia of practical beekeeping.)
- ROWE, H. G.  
1922. Starting right with bees. 128 p. A. I. Root Company, Medina, Ohio.
- SMITH, JAY.  
1923. Queen rearing simplified. 119 p. A. I. Root Company, Medina, Ohio.
- SNODGRASS, R. E.  
1925. Anatomy and physiology of the honeybee. 327 p. McGraw-Hill Book Company, New York City.
- WATSON, L. R.  
1927. Controlled mating of queen bees. 50 p. *American Bee Journal*, Hamilton, Illinois.

**Bee Bulletins and Articles****DEMUTH, GEO. S.**

1919. Commercial comb-honey production. U. S. Dept. Agr. Farmers' Bul. 1039: 1-40.

1921. Swarm control. U. S. Dept. Agr. Farmers' Bul. 1198:1-47.

**ECKERT, J. E.**

1933. The flight range of the honeybee. Jour. Agr. Research 47(5):257-85.

**HAMBLETON, JAS. I.**

1933. The treatment of American foulbrood. U. S. Dept. Agr. Farmers' Bul. 1713:1-14.

**JENSEN, MALITTA F.**

1935. 100 Honey helpings. 31 p. American Honey Institute, Madison, Wisconsin.

**NOLAN, W. J.**

1932. Breeding the honeybee under controlled conditions. U. S. Dept. Agr. Tech. Bul. 326:1-50.

**VANSELL, G. H.**

1931. Nectar and pollen plants of California. California Agr. Exp. Sta. Bul. 517:1-60.

**VOORHIES, E. C., F. E. TODD, and J. K. GALBRAITH.**

1933a. Honey marketing in California. California Agr. Exp. Sta. Bul. 554:1-31.

1933b. Economic aspects of the beekeeping industry. California Agr. Exp. Sta. Bul. 555:1-117.

